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Crystallizing the nexus of network content,
structure, and behaviour in university-business open
innovation research collaborations built for new
product development

This thesis is being submitted to the University of Durham for the degree Doctor of Philosophy,
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ABSTRACT

Crystallizing the nexus of network content, structure, and behaviour in university-business open innovation research collaborations built for new product development

This thesis examines the relational complexities of university-business open innovation networks built for new product development. Through applying network inter-organizational theory, it aims to understand how this relationship type can be developed and managed to create new knowledge and produce mutually beneficial outcomes. This topic is important, as governmental bodies around the globe have developed policy initiatives that encourage universities to play a more significant role within the national innovation landscape, insomuch that collaboration might result in the commercialization of academic research and scientific knowledge and further enhance economic growth and competitiveness within many industries. However, the university-business open innovation literature remains fragmented, and often portrays this relationship type as merely a link to knowledge access or financial resources with little attention given to the complex relational issues that surround the alignment of such diverse partners. This often overlooks the social elements of knowledge generation and the process of innovation emergence which implicates the route value creation (or lack thereof) between affiliated parties.

This thesis posits that value creation, within this relational type, is reliant upon the development, management, and strategic coordination of both externally and internally held social capital stocks. Through examining the functioning of an existing collaborative partnership between a university and a business, utilizing a mixed method social network analysis, light was made on the dynamic nature of how the relationship developed over time, the depth of interaction between partners, and how the actors within the network were organized for knowledge sharing. The analysis provides a greater understanding of the role relational context play on the flows of communication and the emergence of innovative outputs emerge. The main findings of this thesis are that the coupled process of open innovation relationships universities and business relationships require the capability to adapt and engage with the external environment to ensure sustainability. It also finds that contractual mechanisms only enable collaboration to a degree, but are most effective when informal interactions are fostered and, thus, concludes that the effectiveness of value creation might be contingent on local conditions. The findings of this thesis emphasise the risks of standardised approaches to manage encourage university-business collaborations, and provides guidance to managers and policymakers into the nature of these relationships post-award, insomuch that might effectively

structure; as well as anticipate transitions and design elements of the relational exchange. It, thereby, provides a richer theory of university-business collaboration, and contributes to the open innovation literature.

Key Words: Open Innovation, Inter-Organizational Relationships, New Product Development, Social Capital, Network Theory, Resource Dependency Theory

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LIST OF ABBREVIATIONS

BBSRC	Biotechnological and Biological Science Research Council
BIS	Business Innovation Services
DU	Durham University
ESRC	Economic and Social Research Council
EPSRC	Engineering and Practical Science Research Council
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institutions
KBV	Knowledge Based View
IP	Intellectual Property
OI	Open Innovation
P&G	Procter & Gamble
RBV	Resource Based View
REF	Research Excellence Framework
RGF	Regional Growth Fund
SNA	Social Network Analysis
TCE	Transaction Cost Economics

STATEMENT OF COPYRIGHT

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As we express our gratitude, we must never forget that the highest appreciation is not to utter words, but to live by them. -John F. Kennedy

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DEDICTAION

This thesis is dedicated to my daughter, Leia.

You are the best little research assistant, friend, adventurer, and comedian on the planet.

Thank you for sharing this journey with me, and for being a continual source of inspiration.

CHAPTER 1: INTRODUCTION TO THE THESIS

1.1 Research Context and Background

This thesis focuses on illustrating the relational complexities that contribute to the development of new products that emerge from coupled open innovation processes found within of university-business collaborative networks. This form of relational exchange has received increasing interest in recent years for many reasons. The central notion behind open innovation activities is to promote the ease of access to obtain new and exploitable knowledge from external sources (von Hippel, 1988; Powell 1990; Brown & Duguid, 1991; Chesbrough, 2003; Ketchen, Ireland & Snow, 2005) as well as leverage their own internal ideas and paths to the market (Chesbrough, 2003). By transcending the borders of the organization, open innovation *may* present opportunities to access new knowledge stocks which might be difficult to match if operating in isolation (Chesbrough, 2003, 2007; Chesbrough, West & Vanhaverbeke, 2006; Huizingh, 2011; Sisidoya, Johnson, & Gregoire, 2013). However, there are significant complexities associated with the management, coordination, and the realization of innovation, within this relational context, that remains overlooked within research and practice.

A key challenge to firms' innovation activity is to locate, generate or coordinate the resources necessary to fuel innovation activity. Innovation activity places intense resource demands on firms and ultimately a firm's resource endowment and stocks dictate its range of strategic options (Connor, 2002). For instance, in their book on 'Alliance Advantage', Doz and Hamel (1998) emphasized that now, more than ever, the resources and capabilities (critical to the ability to compete effectively) lie outside the direct control of management. It is becoming more widely accepted that relying upon internal innovation to drive firm growth is increasingly sub-optimal. (Hutson and Sakkab, 2006).

The rules of the competition game are never stable and there are many factors that can deteriorate a once strong or 'dominant' organization (Porter, 1990; Chandy et al., 2003). Technological advancements and innovation activities by nimble competitors have shown evidence of their ability to outpace well established and incumbent organizations (Knight & Cavusgil, 2004), regardless of their well-established and well-funded research and development capabilities. Within many industries, it has become evident that a single company may not have access to the extent of knowledge required to provide cost effective or timely

innovations, (Perez-Luno et al., 2011), the flexibility to respond to market fluctuations (Porter, 1990; Rothwell, 1994) or the capabilities to pursue the risky initiatives to be competitive (Powell, 1990). Additionally, many factors such as the ease of market entry, the capabilities of competitors and replication activities, and the deterioration and mobility of human resources of the firm can deteriorate a once dominant market position of organizations with stable technologies (Freeman et al., 1983; Burt, 1992). Many companies are beginning to realize that they may not have access to the knowledge based resources necessary to internally create or maintain a competitive advantage (Kyung et al., 2010) within the dynamic and global markets. We can readily appreciate that many organisations can no longer be solely reliant upon its own innovative resources, activities and processes for new technology, product or business development purposes as the organisation can now acquire critical inputs to innovation from outside sources (Kuratko, Morris & Covin, 2011).

The last 15 years has developed a strong trend towards ‘innovation’ (R&D) outsourcing, as value chains become more disaggregated due to greater product specialization and complex technologies (Hagedoorn & Duysters, 2002; Gassmann, Enkel & Chesbrough, 2010). There are reports that indicate more than 50% of risky and radical innovation projects are completed within the remit of collaboration between partner organizations (Braczak et al., 2009). This topic has cemented itself in product innovation research as companies (e.g., Microsoft, P&G) are decentralizing research activities through networks of external relationships as a means to increasing knowledge acquisition to drive innovation (Gassman, Enkel, & Chesbrough., 2010) with recent reports suggesting that approximately 78% of firms operating with annual sales in excess of \$250 million engage in some form of open innovation activity (Chesbrough, 2013), but the topic is still in need of greater topic diversity (Antons, Kleer, & Salge, forthcoming).

Rather than operating in isolation, firms develop ‘open’ innovation models to connect with external pools of knowledge sources (e.g. SMEs, research institutes, customers, universities) to develop ideas, new technologies, inventions, and intellectual properties into new or refined products using the firms’ own capabilities in R&D, manufacturing, marketing, and/or channel management (Hutson & Sakkab, 2006). The objective is to gain access to the resources necessary to advance their internal capabilities and knowledge stocks through pursuing various forms of collaborative arrangements with external entities (Teece, Pisan, & Shuen, 1997; Ye & Kankanhalli, 2013). This provides firms with the capital-intensive resources necessary to gain time and/or scale efficiencies through joint research, diversify risky innovation by sharing uncertainty, or access new technologies or markets (Powell, 1990; Keupp & Gassman, 2009).

This phenomenon is in part reflective of the idea of ‘open’ innovation strategies (Chesbrough, 2003), in which research has recognized the value of external networks in the innovation process (von Hippel, 1988; Powell 1990; Brown and Duguid, 1991; Chesbrough, 2003; Ketchen et al. 2005).

Open innovation may only present opportunities to access new knowledge stocks which might be difficult to match if operating in isolation (Chesbrough, 2003, 2007; Chesbrough, West & Vanhaverbeke, 2006; Huizingh, 2011; Sisidoya, Johnson, & Gregoire, 2013) but not guarantee the realization of value. Evidence has emerged that innovation does not always result in value creation or mutual benefit, as external objectives may not always align with the internal objectives of either or both firms (e.g. Boeing and LEGO; also, see Parliament, 2014), indicating that there are prevailing misinterpretations of how value can be achieved within this form of relationship presents a considerable amount of risk for partners. The alignment, implementation, and integration of external partners is fraught with complexities; and indicates a potential for conflict that hitherto lacks clarity.

Members of a collaborative partnership, such as those pursuing open innovation strategies, frequently experience challenges with goal misalignment and differing expectations that hold implications for various facets of strategic alignment (e.g. methods of operation within and towards relationships and opportunity identification and exploitation therein) (Bingham & Spradlin, 2011; Klawe, 2011; Michaels, 2013; Zynga, 2013; Cheng & Huizingh, 2014). The complexities of coordinating and managing open innovation are many. For instance, new product development can be viewed as a value adding activity for firms (Deburyne et al., 2002) and a source of competitive advantage (Barney, 1991). However, the act of sharing knowledge sources with external entities contradicts traditional assumptions over protecting core assets (Kline, 2003; Knott, 2003) which has lead firms to prefer the acquisition of new knowledge, but apprehensions remain about collaborative work that includes sharing core intellectual capital (Frishmarr, Ericson, & Patel, 2015). This is counter-intuitive to the process in which novelty and innovation emerge, as the process of generating innovation is contingent upon the complex human and social elements; which impact the ability to share the knowledge necessary to stimulate novelty. This has implications for generating value with knowledge-based activities with external partners.

This thesis focuses on university-business relationships, however the types of partners that can be used for open innovation relationships are many and each may require different

approaches. It has long been acknowledged the variations in partner characteristics that warrant different strategic modes and approaches for alignment and coordination (Barringer & Harrison, 2000). This challenge becomes more complex as firms (and universities) acquire more external partners. The open innovation literature frequently understates the associated complexities of aligning with universities as a knowledge source (Chesbrough, 2003; 2006; West & Bogers, 2014).

This topic is important for universities, as social and political forces are pressuring for greater societal engagement and financial independence from public resources (Wilson, 2012), yet the performance and outcomes of this relational exchange staggers and is falling short of achieving the desired objectives. There is significant evidence that, despite incentives and considerable efficiency benefits, this type of partnership still experiences significant challenges in value creation (Parliament, 2014; Mellin et al., 2016). Reports indicate that academic engagement with commercial research has declined since 2009, with only 14% of academic engaged in industrial collaborations (National Centre for University & Business, 2016). Businesses freely select innovation partners, however recent reports reveal that university partnerships are the least preferred; with 70% of businesses prefer not to interact with universities due to the inflexibility of higher educational institutes and a lack of knowledge as to how they are to develop these relationships (Hughes & Kitson, 2013).

The route to generating novelty and, therefore, innovation is largely contingent on complex human and social elements that must be aligned and coordinated to access, release and generate knowledge necessary for novel outputs (Rodan and Gullunic, 2004; Nonaka, 1994; Kogut and Zander, 1992). Perhaps the greatest gaps within the university-business open innovation literature is the assumption that merely establishing a network will generate value and, therefore, the lack of examinations into how relational elements might function in the route to sustained value creation. Yet, this literature remains largely divorced from the work on inter-organizational relationships, knowledge theories, and social capital theory. This thesis proposes that the current recommendations made at policy, management, and scholarly levels so far about the effective organisation, operation, and management of university–business collaborations are leading to an incomplete and abstract view of how value is and is not created within these partnerships. It aims to contribute to the open innovation literature, specifically those that identify the universities as a potential innovation partner, by merging the conversation with the work conducted on inter-organizational relationships.

In contrast to the open innovation and university-business research, the body of literature on inter-organizational relationships is well developed (Williamson, 1979; Powell, 1990; Barringer & Harrison, 2000). Significant areas of research aim to explain partnership behaviour, the integration of ideas across organizational boundaries, and the transfer of resources on macro and micro levels. While this thesis focuses on the micro level interactions and knowledge exchange that occur between partner organizations in the new product development process, the author found that a brief discussion on the macro level assumptions made within the current university-business open innovation literature enhanced the strength and clarity of the thesis's main argument, research objectives, and analysis. It briefly illustrates the inter-organizational theories how either a transaction cost economics (Williamson, 1979) or an institutional theory (Scott, 2008) perspective has influenced the direction of the current research, and suggests resource dependency theory as an alternative implicit theoretical base for future research on the university-business conundrum.

This study aims to introduce social capital as the theoretical basis for understanding the nature of co-developed knowledge stocks and resource exchange occurring within the open innovation activities built between universities and businesses. Social capital is generally “understood as the goodwill that is engendered by the fabric of social relations and that can be mobilized to facilitate action” (Adler & Kwon, 2002: 17). Resources, both tangible and intangible, are shared within a network of relationships. These relationships are characterised by cooperation and trust as people aim to benefit the greater good (or team objectives), which directly impacts their implicit ‘value’ for transacting the resources available and within the network. The connections (relational linkages) between individuals serve as conduits for sharing knowledge and information necessary for novelty and innovation to occur (Burt, 1992; Wasserman & Faust, 1994; Prell, 2011). Through examining a functioning university-business research collaboration utilizing social capital as the theoretical lens, the social structures, the behavior of the relational exchanges, and the knowledge content being shared, a greater understanding of how the flows of communication, the sharing of knowledge resources, and the emergence of innovative outputs emerge within this relational type.

The challenge laid out by present studies of social capital is to appreciate how relationships can be organised and managed to not merely generate social capital but also to use it to ‘transact’ and ‘transfer’ knowledge and other resources that may go into shaping valuable innovation outcomes relevant to both parties. Therefore, this thesis also aims to contribute the social capital literature in that it aims to reveal the complex nature of relational contexts within

a large-scale network and how the various contingencies of social capital might impact the outcomes and functioning in a collaborative network.

1.2 Research Questions

This doctoral study proposes that the university–business conundrum is truly one of social capital, which holds that merely bringing parties together is grossly insufficient to enable an effective relationship to emerge or for value to be created for any party (in contrast to assumptions in theory and practice). The research questions underpinning this study develop from the failure of open innovation research to appreciate complex aspects of relational dynamics in the generation of innovation outcomes. They also aim to advance what is known about social capital through a comprehensive empirical examination.

1. To what extent do theories of network structure, content, and behaviour individually and in unison explain value creation within university–business relationships?
2. Given the complex interactions in network structure, content, and behaviour, can firms manipulate networks to derive innovation rewards?
3. In what way might network structure, content, and behaviour interact and coalesce to form a richer theory of value creation from university–business relationships?
4. What features of a network relationship can then be replicated and transferred to establish new value creating relationships and what might be local or specific to a relationship?

This study adopts a mixed-method approach to a social network analysis (SNA) methodology. This approach has been adopted to identify the network structure, content, and behaviour to map the regular patterns of interactions and their implications (Wasserman & Faust, 1994). This methodological approach can objectively display the contingencies of how the knowledge and knowledge resources flow between relational channels within networks that has both theoretical and practical implications (Prell, 2011). This approach emphasizes the examination of inter-dependent relational processes and the components that influence not only collective action but also aids in predicting behavioural outcomes at the individual actor level to robustly define the phenomena of interest (Hanneman & Riddle, 2005). The relational linkages between actors serve as conduits for the resource flows (Granovetter, 1985; Burt, 1995). The prevalence of behavioural characteristics of the individual actors can be used to define compositional elements and helps to categorize specific clusters or cliques to describe

variance within a dynamic network (Wasserman & Faust, 1994). This analysis seeks to identify and map the relational elements that enable (or constrain) the cross-functional resource flows that enable innovation and define the interactions between network structure, content, and behaviour.

1.3 Organization of the Thesis and Contributions

This thesis is comprised of 7 chapters; an introduction (chapter 1), a literature review (chapter 2), research design and methods (chapter 3), three different forms of analysis (chapters 4, 5, and 6), and a conclusion (chapter 7). It aims to make several important and original contributions to theory and knowledge.

The focus of **chapter 2** is to review the extant **literature** surrounding open innovation, university-business technology transfer research, and inter-organizational networks, with the overall purpose of clarifying the debates surrounding the management and coordination of open innovation activities for firms and universities. The chapter opens with a discussion of the context of innovation activity for firms and the resource intensive nature of managing new product development. The section that follows focuses on providing a brief over-view of open innovation and the various modes of knowledge transfer. It illustrates the assumed mode of knowledge transfer between a university-business is one directional within several key bodies of literature. This is also evidenced in the section review of that discusses the context of university-business relationships.

There is a growing body of literature that focuses on the performance of technology transfer, the impact of university commercial activities on society's knowledge base, and the recent political measures designed to facilitate this form of inter-organizational relationship. The section proceeding reviews the university-business technology transfer literature. As will be presented, this stream of literature largely overlooks the existing work on inter-organizational relationships. For instance, there are several implicit inter-organizational behaviour theories found within the university-business literature. Much of the work conducted on university-business relationships has adopted implicit assumptions of either transaction cost economics or institutional theory. This section aims to illustrate how these implicit assumptions have guided the research streams in this area and why resource dependency theory can provide new insights into the university-business conundrum. This section closes by aligning the various forms of university commercial activities with streams of inter-organization forms that closely align in terms of their nature and objectives. This section identifies the network as the

most closely aligned inter-organizational mode for large scale university-business coupled process of open innovation for new product development.

The final section of the literature review discusses theories of micro-level processes embedded in university-business relationships, theories of inter-organizational networks, and knowledge transfer. It discusses the composition and complexities of managing this form of relationship, and the challenges of knowledge transmission and flexibility that this format provides for organizations. The section briefly discusses the composition and complexities of sharing the knowledge necessary for stimulating innovation and why relational links must be managed in a way that facilitates tacit/complex knowledge. The thesis then proposes that social capital as the key to unlocking valuable outcomes in the university-business. It unpacks the dimensions the behavioural, structural, and content specific aspects that characterise the literature and concludes by emphasising the importance of developing an understanding of the relational contexts and components to enhance our understanding of the nature of networks, social capital, and innovation emergence in this relational type.

This thesis responds to the repeated concerns that the theoretical development of social capital and theories of networking more broadly are outpaced by its empirical development (Hughes et al., 2014; Rodan and Galunic, 2004). This study aims reconcile theories of network structure, content, and behaviour to provide a first attempt at a complete theoretical *and* empirical treatment of the problem of value creation from network relationships. Specifically, the analysis chapters adopt three broad themes to paint a picture of the relational context complexities of the university-business coupled process of open innovation networks. The investigation of this project included network dynamics (**Chapter 4**), network boundaries (**Chapter 5**), formal network structure (**Chapter 6**), and informal network structure (**Chapter 6**).

The research design and methods will be discussed in **Chapter 3**. The chapter begins by outlining the objectives and rationale for the study. The second section further characterises the research objectives by clarifying the critical realist philosophical stance of the researcher. The section that follows illustrates the exploratory and descriptive research design. The following section discusses the necessity for a social network analysis methodology to reveal the depth and interaction patterns found within university-business relationships, and will be proceeded by a discussion of the multi-method approach taken for data collection. It begins by discussing the decision made for combining qualitative and quantitative methods, along with,

ethical considerations made prior to data collection. The chapter then moves to discuss the holistic case study approach taken for this investigation and a description of the research site. This section then provides an overview of the informants contacted. The chapter then considers data safety and storage. The section proceeding then presents the data collected. It begins by illustrating the different techniques of collecting from primary data sources. Direct observations were collected in the form of technical meetings and public presentations. Participant observations were collected through semi-structured interviews and board meetings. A final form of primary data was collected through a cross sectional survey. Secondary data was collected in the form of archival documents. The chapter concludes by providing an overview of the analysis techniques and network measures used in each of the empirical chapters.

The focus of **Chapter 4** will present the first empirical analysis on the **network dynamics** utilizing a thematic and chronology analysis. The first empirical study within this project focuses on revealing the dynamic and self-organizing processes in which the relationship was built. A chronology and thematic analysis of archival documents, interviews, and participant observations to reveal four developmental phases of the relational exchange. This approach has been adapted from Cross & Parker (2004), who identified the first three phases of (organizational) network structure within an organic team. However, this adaptation of their theory and extension reveals additional contingencies and evidence that there have been four key phases to the development and coordination efforts. The transition from each phase of development was characterized by tipping points that stimulated dynamic change and focus within the social context of the organization (Gladwell, 2002). Each phase presented a new dynamic and challenge that required complex social processes to be coordinated; which had implications for the network structure and operational focus, and demanded actions to shift the organizational focus and to maintain the vitality of the relational exchange for continued value creation. While research has been conducted within the remit of organizational ecology and industrial marketing management studies, to the researchers' knowledge there has not been studies conducted on the development of open innovation or university-business relationships over time. It also illustrates the socially complex nature that contributes to the endogenous nature of open innovation network development. These findings suggest that multifaceted adaptive processes are essential to sustainability for this network type but are often overlooked in network studies.

Chapter 5 presents an empirical study that focuses on clarifying the extent of network boundaries and external influences that impact university-business relationships, inasmuch that institutional influence and external pressures dictates development and decision making process, and thus the value creation. Frequently, studies select partnering members within a relational dyad as the focal point for investigation. However, the boundaries and the level of influence of external network activities and pressures are likely to make considerable impacts on the behaviours and outcomes. This chapter aims to reveal the networks embedded within the university-business open innovation network. A key theme that emerged from this investigation was that the influence of external networks and weak ties impacts the internal network behaviour in significant ways, and operational considerations must consider the extent to which innovation activity exist beyond the focal dyad.

Chapter 6 will discuss the analysis of the formal and informal mechanism driving the collaborative nature of the relationship. A network analysis technique will to map inter-connections between members of the relationship to illustrate the extent to what formal coordination can explain the nature of information flow and interactions. The formal structure of the network is coordinated in a way that encourages opportunity among the members, and was defined by the coordination made by contractual arrangements and the obligatory task interdependence outlined in the Master Agreement. This merely illustrates the network connectivity among actors' specific functions, which has been assumed to be the guiding force in facilitating the generation of the knowledge and innovation outputs. As illustrated, the formal structure is coordinated in a way that encourages opportunity fluidity among the members. However, the successful generation of innovative outputs within this research site reveals that although the network has been built strategically, operational effectiveness relies on other forms of social obligations that exist beyond the contract.

This study employs a range of qualitative data to illustrate how the informal network facilitates collaborative behavior, inasmuch that its prevalence results in value creation, innovation, network growth, and sustained results. Evidence from this examination reveals the influence from the informal social capital structures that contribute to mutual benefit and value creating knowledge generation. Measures also revealed that value creation within this network was not limited to tangible outputs, such as patents and publications. Value was created in the experience of learning and the sharing of ideas that stimulated more compelling projects for either end of the partnership.

Chapter 7 presents the final discussion of the study. It begins by providing a brief synopsis of the study before restating the theoretical and practical conversations the author aims to contribute to; open innovation, university-business, and social capital/network theory. It summarizes the research designs and methods, before re-emphasising the conclusions made analysis and findings. This chapter revisits the overarching research questions and propositions developed. The propositions are addressed utilizing the findings and conclusions of the three empirical chapters. The chapter then address the solutions and finding for the over-arching research questions and objectives. While there are several aspects of network coordination that hold the potential for replication to other university-business research collaborations, there are several aspects that hold the potential to be confined to local conditions. The chapter then moves to discuss the scholarly contributions and implications before discussing the practical implications for policy-makers and managers. The section that follows will acknowledge the study's limitations. The final section will provide the author's reflection and concluding remarks.

CHAPTER 2: LOCATING INTER-ORGANIZATIONAL RELATIONSHIPS WITHIN THE DEBATE ON INNOVATION, OPEN INNOVATION, AND UNIVERSITY-BUSINESS RELATIONSHIPS

2.1 Introduction to the Chapter

This thesis focuses on illustrating the social and relational complexities that contribute to the development of new products within university-business open innovation (OI) collaborative networks. The previous chapter introduced the topic of open innovation and how this practice has gained momentum and importance among businesses, universities, and policymakers in recent years. It is evident that the potential benefits and efficiencies that may emerge from this form of partnership are substantial, yet fundamental questions remain regarding the route to sustained value realization and alignment among such organizationally diverse partners.

This objective of this chapter is to locate theories of inter-organizational relationships found within the debates found within the literature on innovation, open innovation, and university-business, and aims to illustrate the complexities that surround the process of initiating and organizing university-business relational networks. It begins by reviewing the challenges firms face in developing the resources necessary for fueling innovation activity. This section emphasizes the traditional modes of resource acquisition for firms, and how traditionally applied approaches might be insufficient for planning the appropriate knowledge exchange mechanisms in university-business collaborative partnerships. The section that follows discusses the different modes of open innovation, which is largely determined by the intended direction of knowledge flows. The chapter then moves to discuss the context of universities and the complexities associated with their overall functioning and commercial capabilities. It then provides an overview of several inter-organizational theories and their applicability to this relational type. It is well known, within the inter-organizational relationship literature, that variances in partner characteristics and their corresponding objectives complicates assessment, alignment, and mutual benefit might be achieved. This thesis proposes that new insights can be made to this relationship type through introducing the body of work conducted on inter-organizational relationships. The final section then discusses university-business inter-organizational networks, and the theory of social capital. The thesis proposes that the performance of university-business open innovation and relational exchanges is related to the ability of both partners to be capable of generate and manage social capital.

2.2 Developing Innovation Resources for Firms

There are many contextual and locally specific factors that impact the ways that organizations develop their innovation strategies. This section of the literature review aims to provide a discussion on the resource intensive nature of generating the knowledge stocks necessary to stimulate innovation activities. There are many factors impacting the route to development of the knowledge stocks needed to be competitive, including the composition of knowledge and the underlying views of the firm. It has long been acknowledged that an abundance of knowledge resources has the potential to contribute to innovation development.

This section begins by illustrating the context and importance of innovation activity for firms. It discusses the challenges firms face in the acquisition of knowledge resources necessary to fuel innovation activity before presenting the complex aspects of knowledge generation. This section aims to reflect that some of the most widely adopted and traditionally applied logics in strategy and within the current research and business practices could inhibit the effectiveness and development of open innovation strategies for firms. This section also states that traditional theoretical lenses falls short to explain or forecast innovation performance when acquiring external knowledge. Then, it will show how resource demands and this logic impact the pursuit of incremental or radical innovation outcomes, and why it is necessary for the literature to transition to a knowledge-based view. The knowledge based view is an extension of the resource-based view and emphasises that the elements of strategy development must recognize the significance of knowledge (and learning) as a resource. It argues that the resource-based view falls short to appreciate the value of resources or capabilities that the firm does not, or will not, have direct control of.

2.2.1 Context of Innovation Activity for Firms

An innovation can be thought of as any *new* product, process, practice, or idea that possesses commercial applicability (Rogers, 1995; McEvily & Zaheer, 1999). The term innovation has been broadly applied by scholars and researched from the perspectives of many scholastic communities to address each community's particular audience and interests (Garcia & Calantone, 2002; Hauser, Tellis & Griffin, 2006). For instance, the term has been applied to new products, marketing, business processes, and business models (Chesbrough, 2003). In turn, the literature is replete with different types of innovation, from incremental to radical, continuous to discontinuous and disruptive (Veryzer, 1998; Calantone, 2002; Danneels, 2004; Garcia, Govindarajan & Kopalle, 2006); and from product to service (Storey and Hughes, 2013) and architectural to process and management (Henderson & Clark, 1990; Benner &

Tushman, 2002; Birkinshaw, Hamel & Mol, 2008). While this creates challenges in interpreting a common definition for innovation, it does reinforce the broader value of innovation activity in transforming the short, medium, and long term future objectives for firms.

A large body of well-established literature identifies innovation as a fundamental source of competitive advantage (Schumpeter, 1946; Merrifield, 1993; Porter, 1990; Tushman & Nadler, 1986; Chesbrough, 2003). Stimulating innovation activities are important because it hold promise for value creation; whether they be through the development or improvement of new products/services or process improvements that build better business practices (Pettigrew & Fetton, 2000; Ye & Kanknhalli, 2013). A common thread across studies of innovation, irrespective of perspective, over the past 30 years however is that, “[t]here is perhaps no more pressing managerial problem than the sustained management of innovation” (Tushman & Nadler, 1986: 92) such that, “any company or commercial organization that is not continually developing, acquiring and adapting advancing technology [and so innovating] likely has made an unintentional strategic decision to be out of business within a few years” (Merrifield, 1993: 383, see also Tang, 2006). Such stark warnings call on firms to develop innovations now while also working to develop future innovations that may undermine its historical or ongoing activities but for the promise of a better envisioned future (Birkinshaw & Gibson, 2004). The fundamental danger however is to under-appreciate the complexities associated with the planning for innovation (Tushman & Anderson, 1986).

Despite the different forms of innovation, this thesis is primarily interested in product innovations, although these innovations themselves may depend on (or develop from) technological or process innovations that come to inform the product innovation (Benner & Tushman, 2002). Product innovation has been described as the “lifeblood of firms” (Slater, Mohr & Sengupta, 2014: 1) and is ranked among the top three strategic priorities for 71% of firms according to the Boston Consulting Group Senior Executive Innovation Survey (Andrew et al., 2010). This remains in contrast to a backdrop of studies by the Product Development Management Association, which found that only 59% of new products taken to market are ‘generally’ successful with only 54% of commercialized new product innovations typically successful in profit terms (Barczak, Griffin, & Kahn, 2009).

The necessity for such rigour stems from reports that, “one product concept out of seven becomes a success and roughly half of the resources that industry devotes to product innovation is spent on failures and killed projects” and “that new products face an average 35 per cent

failure rate at launch” (Ahmed & Shepherd, 2010: 166). Research by Cooper (1990) has also shown that only one out of four new product development projects are successful. But in contrast to such concerns, there remains clear empirical evidence that successful innovation can bestow financial rewards on firms, including increases in operating cash flows and higher firm valuations by equity markets (Evanschitzky et al., 2012).

To ensure survival, firms must coordinate the resources that are needed to fuel innovation activity and new product development, both in support of the short-term and the long-term objectives of the organization (Connor, 2002). Firms must innovate incrementally to sustain the competitiveness of their current products while also innovating radically to prepare for future products and markets (Gibson & Birkinshaw, 2004). For a new product/process to be classed innovative, an invention or process must possess the ability to improve value propositions through some form of commercialization or efficiency savings that improve profit margins. However, a focus on the ultimate success of new product innovations obscures a more important consideration: generating innovation activity is resource intensive.

Commonly, firms develop research and development (R&D) laboratories as a specialised unit and a long-term commitment to enhancing their innovation portfolios and product performance (Hagerdorn, 2002). The R&D laboratories activities act as the front end of the innovation process for firms, yet the intensity of the investments made and activities conducted are impacted by the technology and developments of the industry the organization competes, with R&D intensity ranging from 3.5% of revenues within established industrial based products to over 42% over revenues for bio-technology (Business Enterprise Research and Development, 2012). These labs are typically staffed with a collection of scientists and experts who work towards developing applied science or new technologies to be integrated into existing products or in the pursuit of something new. Their primary focus is on the development of new technologies, the R&D department often manages a product through to commercialization stages. The overarching goal for this department is in the development and the acquisition of knowledge resources for a firm and there has been considerable research on how to best acquire these resources (Penrose, 1959, Williamson, 1973; Drucker, 1988; Barney, 1991, Grant, 2002). The rate of under-performance and the emergence of competitive activity (Christenson, 1996) has stimulated the desire to acquire external ideas and opportunities (Dodgson et al, 2006; Du et al., 2014), but further problems ensue when considering how firms can address the resource intensive nature and the complexities of generating the knowledge-related benefits and how innovation may emerge (Newman et al., 2002). An organization may

face challenges in integrating a variety of decision processes which may pass through various stages of acceptance before exploitation (Meyer and Goes, 1988). The next section will discuss the nature of knowledge resources.

2.2.2 Generating Knowledge Resources for Innovation

The capability to continuously generate novel insights is often considered to a key strategic resource for firm engaged with innovation activities. The process of generating these resources are rife with complexities and difficult to sustain. For instance, there is a large body of literature that analyses the composition of knowledge based activities and the impact on variations on innovation outcomes. Polanyi (1966), for example, defines two specific states of knowledge, tacit and explicit. Explicit knowledge is defined as the knowledge that is easily codified and transferred among actors, such as the documents and data collection. This form of knowledge provides firms with benefits of standardization and quantifiable data (Nonaka, 1991). Tacit knowledge is defined as the form of knowledge that lies within the mind of the actors within the network. Tacit knowledge is not as easily communicated, such as the routines, practices or highly specialized capabilities and serves as a conduit that facilitates efficient knowledge transfer between actors and can provide an impetus for innovation (Polyani, 1966).

Tacit knowledge is not easily replicated, communicated, or transferred and is likely to be embedded within the individual capabilities found within the human capital held by a firm (Nonaka, 1994; Subramanian & Venkatraman, 2001) and is the root of idea generation (Castiaux, 2007). Over time, members of firms acquire experience, learn through overcoming challenges, and collect knowledge stocks regarding how to efficiently and effectively operate with a form of knowledge that often becomes embedded in its documents or repositories, routines, processes, and practices (Price, 2007). This form of knowledge must be intentionally disseminated among organization members to encourage innovation (Tsai, 2001) to increase the breadth of knowledge necessary to stimulate innovation (Christensen, 1996; 2004) and relies on relational capabilities (Stasser, 1992).

The development of innovation is an interactive process (Edquist & Hommen, 1999). Knowledge sharing activities can provide opportunities to stimulate and contribute to their collective and individual abilities to innovate (e.g., Kogut & Zander, 1992; Tsai & Ghoshal, 1998; Tsai, 2001). It involves social complexities and human elements in opportunity identification, the development of new knowledge, and, often, the transfer of difficult to codify (tacit) knowledge and absorption (Cohen & Levinthal, 1990; Autio et al. 2000). Tacit has long

been acknowledged as a fundamental and strong impetus for innovation (Madhavan & Grover, 1988, Nonaka, 1994; Nonaka & Takeuchi, 1995), however it is difficult to communicate and often relies upon individuals developing strong relationships, high levels of motivation, and integration with partners (Tsai & Ghoshal, 1996; Uzzi, 1996, 1997; Fitcher, 2009; Belenzon & Schankerman, 2014).

There are several positions within the literature regarding how the process of innovation and new knowledge generation may emerge between individuals. Some researchers argue that the ‘knowers’ must be capable to absorb external knowledge and recognize the relevance to currently held knowledge stocks (Cohen and Levinthal, 1990; Hughes et al., 2014). The theory of absorptive capacity proposes that knowledge obtained in the absence of prior knowledge (or relevance to the core activities of the firm) will not possess innovation capabilities (Cohen & Levinthal, 1990). Additionally, there must be a level of distributed learning in open innovation and inter-organizational relationships (Lane & Lubtkin, 1998; Robertson, Casali, & Jacobson, 2012). Of the utmost importance, and as Kogut and Zander (1992) noted, learning has a relational component that makes it contingent on the value of social relations (e.g. social capital) that makes the combinative capabilities possible.

Research suggests that the conditions attributable to innovation (or new knowledge creation) requires the disparate connection of knowledge from disparate sources (Hargadon & Sutton, 1997). The knowledge pursued and transferred within the organization can be identified as a mixture of scientific expertise, organizational culture, and contextualised information and insight that allows members to incorporate new information into the firm’s operations, activities, or products (Davenport & Prusak, 2000; Price, 2007). Innovation performance and outcomes are associated with the capability to connect new knowledge to previously held knowledge stocks and making either radical or incremental new combinations (Nanapiet and Ghoshal, 1998). This becomes more complex within inter-organizational networks, as firms are apprehensive to share core elements of product design with external entities (Kline, 2003) and fear for knowledge spill overs (Athuana-Gima, 2005; Knott, 2006) (as related to the discussion on the resource based view in section 2.2.3) and create rigid process that undermine innovation performance. Alternatively, some research suggests that firms that adopt fully organic and complex responsive systems to enhance knowledge flow and innovation within networks (Stacey, 2001; Katz, 2006; Sorenson, Rivkin, & Fleming, 2006). Thus, supporting knowledge creation and sharing in networks (Cross et al., 2001) involves developing normative

behaviours and communities of practice that motivate learning and innovation (Brown & Duguid, 1991; Belenzon & Schankerman, 2014).

A strong relationship between actors in an inter-organizational network has been associated with the transfer of complex knowledge. Relational capabilities (e.g. trust and interaction) must be developed to address the desire to protect resources, yet foster the knowledge exchange required for innovation (Kale, Singh, & Perlmutter, 2000) and enable the heterogeneous knowledge to flow within the network (Knott, 2003). Therefore, fostering this act of knowledge sharing has been associated with the organizational climate (Brock et al., 1994) that promotes acceptance and acclimation of innovation (Myer & Goes, 1988) and knowledge combination capability within inter-organizational networks that relies upon relational capabilities (Carmeli & Azerouli, 2009) and appropriate responses to various external factors.

While studies provide evidence that strong social relationships (among embedded ties) are best suited for complex information diffusion, they also acknowledge a threshold of usefulness and a point at which ties become redundant for novel information (Uzzi, 1996, 1997; McEvily & Marcus, 2005). There are several arguments that suggest weak relational links provide diverse sources of information and improves the possibility for novelty to emerge (Granovetter, 1973; Burt, 1992). This theoretical tension indicates that knowledge emergence and novelty performance requires an innovation network may be characterised by a combination of strong and weak relationships. Developing the knowledge resources necessary for fuelling innovation activities becomes more complex, as the locally specific treatment and views of knowledge management varies per organization. These variations in views may directly impact the ways in which innovation activities are organized as well as the strategic approach to the acquisition of knowledge resources are obtained, either through internal or external processes (Nonaka, 1991). The next section considers the impact of the underlying theories of the firm adopted by the researchers or managers in the development of these strategies. It aims to illustrate the widely-adopted logic that is applied within firms and research, the resource based view. It aims to highlight how this logic poses implications for innovation strategy and knowledge management.

2.2.3 The Resource Based View of the Firm and Innovation Activity

Innovation activities are important for firms to enhance their market positions and competitive actions, and the methods firms use to acquire the knowledge resources, necessary to engage in innovation activities vary considerably across organizations and contexts (Rothwell, 1994). As mentioned previously, firms often commit significant capital investments in the creation of research and development laboratories (Miller, 1991). The managerial approaches and processes associated with the performance and functioning of these departments varies widely (Christensen, 1996; Hutson & Sakkab, 2006). However, a theme that emerges across the research conducted on the field and in practice has relied upon several implicit assumptions that align with the Resource Based View of the firm and that which focuses on the internal development of innovation capabilities within the firm (Penrose, 1959; Barney, 1991).

The resource based view proposes that the internal functions and inputs determine a firm's ability to develop sustain unique forms value creation and competitive advantage. Any resource (or capability) possessed by a firm must be valuable, rare, and inimitable and difficult-to-substitute to be considered a source of competitive advantage. A core assumption under the RBV is that it assumes that no two firms are identical and that the isolation of these unique resources and capabilities provide advantages within an industry (Teece, Pisan, Shuen, 1997; Knott, 2003). Barney (1991) indicates that sustainable competitive advantage has been achieved "when it [the firm] is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy" (1991: 102). Thus, the nature of R&D knowledge creation and the technological discoveries therein can contribute to preventing the inimitability of a strategy (in this case an innovation strategy).

The resource based view suggests that the innovative results generated by the R&D activities can only be considered a source of sustainable competitive advantage in the presence of isolating mechanisms which can prevent replication activities by competitors. Complexities, such as knowledge stocks developed within product design and internal processes, contribute to a firm's inimitable resource base. The firm can also provide access to excess knowledge stocks through various forms of divestiture or spin out activities, which can thus improve business performance (Carmeli & Azeroual, 2009). The complexities of the route to knowledge generation may fulfil the difficult-to-imitate criteria essential to achieving a sustainable competitive advantage under the resource based view. Therefore, the experience and

knowledge generated can then be viewed as an asset or a form of capital utilized in the pursuit or retention of a competitive advantage (Mowrey et al., 1996). The knowledge generated from internal activities and techniques must be protected, retained, and hidden from competitors so to block the replication efforts of the competitors. The assumption of inimitably underpinning the resource based view has implications for organizations competing within dynamic markets (D'Aveni et al, 2010) and aim to develop collective innovation activities with external entities (e.g. Kogut & Zander, 1992; Tsai & Goshal, 1998).

In the presence of short-term advantages in the contemporary competitive environment (D'Aveni et al., 2010) in which rapid changes, sophisticated competition (Porter 1990) firms need to develop techniques to manage innovation capabilities to capitalize on opportunities to enhance the knowledge stocks necessary for sustaining innovations and fill in the gaps of resource deficiencies (Chesbrough, 2003, 2006). Members of firms acquire experience, learn through overcoming challenges and collect knowledge stocks regarding how to efficiently and effectively operate with a form of knowledge. As mentioned previously, there is significant evidence to suggest that innovation emergence (or new knowledge generation) requires some level of knowledge diversity and varying social interactions (e.g. Hargadon & Sutton, 1997; Knott, 2003; Sorenson, Rivkin, & Fleming, 2006). The anticipated outcome of the innovation activity also adds levels of complexity, as each form of innovation warrants different forms of invested resources (e.g. financial, human, time).

Planning for innovation outcomes presents its own set of benefits and challenges with not only setting expectations but also in the definition of strategic priorities and resource allocation. The complexities of planning for innovation outcomes helps to explain why some firms may or may not pursue riskier initiatives (Schumpeter, 1942; Christenson, 1996). For instance, firms that have products which have performed well historically become hard to let go of or difficult to change dramatically because the revenues associated with them are comforting in the short-to-medium term (Audia et al., 2000). The firm may opt to focus innovation activities and resources towards incremental improvements to existing products and services. Incremental innovations assist in sustaining the performance trajectory of firms and their products to meet consumers' growing expectations about product quality and product features. Incremental innovations then are typically favoured when products are at the advanced stages of the product life cycle, and continuous incremental innovation is an effective tool to achieve standardization and maintain status quo within an industry (Garcia & Calantone, 2002), through product improvements or finding new techniques to ensure an efficient

manufacturing process. This is generally low risk in comparison to costly and risky radical innovation (Daneels, 2004). However, there are risks of becoming locked into the status quo and developing path dependencies on technologies that can be circumvented by competitors.

Incremental innovation can therefore be defined as “products that provide new features, benefits, or improvements to the *existing* technology in the *existing* market” (Garcia & Calantone, 2002: 123, original emphasis) and an “incremental new product involves the adaptation, refinement, and enhancement of existing products and/or production and delivery systems” (Song & Montoya-Weiss, 1998: 126). The value incremental innovation provides to a firm should not be discounted though. For many firms, incremental innovations are essential to the sustainability of the firms’ operations (Garcia & Calantone, 2002) and can still be a valuable ‘competitive weapon’ to keep competitors at bay by trapping them in a sub-optimal competitive state of continuously playing ‘catch-up’ to a firm proficient at continuous incremental innovation (Johne & Snelson, 1988).

The danger to a firm proficient at incremental innovation at the expense of radical innovation, however, is that it is perpetually at threat from obsolescence or circumvention by the innovation activities of the competition (Frosch, 1996; Voelpel, et al., 2005). This threat comes not only from innovative new entrants into a market but also from the radical innovation activity of other incumbent firms (Chandy & Tellis, 2000). A firm’s competitive position, even at the best of times, should be thought of as fragile because of the potential for it to become victim to the radical innovation activity of other firms (Chandy et al., 2003). Radical innovations are defined as “innovations that embody a *new* technology that results in a *new* market infrastructure” (Garcia & Calantone, 2002: 120, emphasis added; see also (Colarelli O’Connor, 1998; Song & Montoya-Weiss, 1998). A radical innovation can therefore generate discontinuities at the industry, firm and customer levels, creating new markets or obsoleting existing ones (Schumpeter, 1942; Slater et al., 2013) tending to create new demand as opposed to supplementing existing demand. Radical innovations in this respect can disrupt entire markets (Govindarajan & Kopalle, 2006) and create new ones that in themselves create new competitive space for new entrants to fill (Garcia & Calantone, 2002), often with subsequent incremental improvements (Cheah, 1990). As incremental innovations are easier to forecast, they face the possibilities of being predicted, replicated, or outdone by more innovative competition. Still, a firm relying solely on a radical innovation strategy is potentially placing itself at considerable risk.

In contrast to incremental innovation activity, new product development centred on the pursuit of radical innovation is riskier and more resource intensive (Song & Montoya-Weiss,

1998; Stringer, 2000; O'Connor & Rice, 2001), and thus places a considerable drain and demand on firms' current and future resource stocks. This challenge is made more complex by the need for firms to innovate incrementally to sustain the competitiveness of their current products while also innovating radically to prepare for, and potentially shape, future products and markets (e.g., Birkinshaw & Gibson, 2004; Simon et al., 2010).

A radical and disruptive innovation carries the potential to create new markets and significant rewards, however this type of innovation carries the greatest risk and uncertainty despite its potential (Bowers & Christensen, 1995; Christensen, 1997). For example, new technologies that offer a significant differentiation from currently available options can be classified as radical innovations. The risk associated with radical innovation is due to ability to forecast demand and acceptance among consumers, as a concrete market may not exist prior to its implementation. Porter (1995) suggests that the advantages to adopting these innovations prior to a competitor developing innovation rests in its potential to build brand loyalty and 'first to market' advantages in the form of dominant product designs (Reiner, 1989; Conway & Stewart, 2009). The unpredictability of consumer adoption rates adds risk as firms may not be able to forecast the acceptance of the new technology or product using traditional and conventional means of market research (Frosch, 1996) as advancements in technologies can sometimes develop faster than the market or simply lack the capacity to be exploited.

There are many industries that have enjoyed the ability to plan operations based on stable demand, but they are now being challenged to improve their value proposition(s) to consumers. Once dominant firms now face challenges of rapid depreciation of their current resources and capabilities as sophisticated new entrants pose a larger innovation threat (Chandy & Tellis, 1998; 2000). Historical investments in products, services, core technologies, and the resources that underpin them subsequently lead firms to prefer incremental improvements over and above disrupting these long-standing products and their associated investments (Utterback, 1994; Chandy and Tellis, 2000; Chandy et al., 2003; Tang, 2006). Against this backdrop, scholars have foreseen a gloomy future for incumbent firms, noting that as firms become more dominant, they become more wedded to the status quo and reluctant to innovate radically (Schumpeter, 1942; Cooper & Schendel, 1976; Henderson, 1993; Chandy, Prabhu & Anita, 2003). The result can be stagnation on internally developed innovation.

The process of generating innovation is reliant upon the people in the organization. It has long been established that an organization's employees are those that possess the resources

and capabilities to enact strategic objectives (Shultz, 1961; Becker, 1964; Field, 2003). The notion that human actors provide was developed as human capital in which economists could quantify the concept of the capital resources that are embedded within human skills and competencies (Field, 2003). Human capital supports the resource based view as it contributes to competitive advantage and is largely inimitability, firm-specific, and socially complex which reduces the firms' costs and contributes to innovation as learning improves (Hatch & Dyer, 2004). As firms view these knowledge stocks as a strategic resource (Grant, 1991; 1996), they make efforts to ensure that these retain the inimitable assets utilized within the competitive market. To cultivate human capital advantages, especially within high technology sectors that require frequent innovation, many firms have invested heavily in hiring the best individuals to generate knowledge stocks through superior human capital.

For a firm to rely solely upon the innovation developed internally to drive growth is increasingly sub-optimal (Ketchen, Ireland, & Snow, 2007), yet the implicit assumption of the resource based view prevails and suggest developing heterogeneous resources that are inimitable by the competition. Generating the internal knowledge resources for innovation activities can be inefficient in many ways (e.g. costly, resource intensive, risky, and unpredictable) as evidence suggests that research and development laboratories are faltering while innovation budgets climb faster than revenues (Christenson, 1996). The resource based view falls short in providing an explanation potential for resources to be accessed, utilized, and valuable without the firm vertically integrating or protecting the knowledge stocks internally to prevent external homogeneity. This view overlooks the potential for external sources to be managed in a way that allows for mutual benefit in joint problem solving activities or inter dependence in innovation activities amongst external parties (e.g. Tsai & Ghoshal, 1998; McEvily & Zaheer, 1999; Kale, Singh & Perlmutter, 2005) and presents limitations to knowledge acquisition strategies, as well as organizational culture and internal processes.

The prevalence and trends of worker mobility and shifts between organizations threatens the potential for replication by the competitors' poses additional risks; as the investment made human capital development is not sustainable and there are risks of knowledge spill-overs. The risks of knowledge heterogeneity, knowledge spill-overs, and the ease of replication between the competition (Knott, 2003; Rohrbeck, Holze, & Gemunden, 2009). Knowledge has become a frail commodity, in that organization invest and financial support the development of intellectual capabilities that cannot be protected or retained for optimal and sustained performance (Field, 2003). The impending external distribution of

knowledge threatens to improve competitor capabilities or encourage spin off opportunities for venture capitalists which would undermine the long-term advantages sought and allows access for replications to be achieved at lower costs (Rivette & Klein, 2000; Klein 2003 Porter, 2005; Chang et al., 2006; Alencar et al., 2007; Lee et al., 2008; Hossain, 2012). Therefore, it might be expected that under conditions in which knowledge investments provide little or short lived advantages, many firms will need to pursue a less traditional means to acquiring external knowledge and managing internal knowledge stocks to competitively innovate.

Research has begun to argue the competitive battles in contemporary markets require a paradigm beyond the traditional application of the resource based view (for an example see Teece, Pisano, & Shuen 1997). Technological advancements and innovation activities by competitors threaten to outpace even the most established and incumbent organizations' research and development capabilities (Hill & Rotharmel, 2003). This is further impacted by replication activities across industries, and the deterioration and mobility of human resources, and the ability to deteriorate a once dominant market position for organizations with stable technologies (Freeman et al., 1983; Burt 1992). It has become apparent that the resources and knowledge might not be possessed by single company (Perez-Luno et al., 2011) but through the network of relationships held by the firm (Chesbrough, 2006).

There are concerns that the resource based view can no longer sufficiently explain successful innovation activity (McEvily & Zaheer, 1999; Knott, 2003). The idea of possessing and holding key strategic resources internal to the firm contradicts the demands of external collaboration and the sharing of ideas necessary to fuel innovation (Atuahene-Gima, 2005). From a resource based view perspective, this may seem sensible as a firm seeks to draw on the valuable resources of others to fill gaps in its own stocks. However, this perspective fails to appreciate why access to such resources may or may not be granted, be granted to unequal degrees, or can subsequently be relied upon (Sorenson, Rivkin, & Fleming, 2006). Therefore, the resource based view is best suited to explain conditions within a static environment in which long term sustainable advantage is possible through eventual economic equilibrium (Barney, 1991). However, the adoption of open innovation activities suggests resources and capabilities that result in competitive advantages might be located both within and beyond organizational boundaries. The sourcing of externally held resources indicates a separation of ownership and control, and creates a different perspective on how resources are accessed and leveraged to fuel innovation activities. This shift in organizational behaviour suggests an adaptation to the RBV and to how resources and capabilities are developed and sourced.

2.2.4 The Knowledge Based View of the Firm for Innovation Strategy

The knowledge based view (KBV) provides an alternative conception of how strategic resources and capabilities can be accessed to provide competitive advantages within dynamic markets and is an extension of the resource based view (Grant, 1991). The KBV proposes that knowledge-based resources are the most significant assets that a firm can possess. The social complexities associated with knowledge generation present the firm with a stock of competitive assets, which possess the qualities of inimitability and heterogeneity that can provide superior returns (Grant, 1991, 1996). Popularized by Peter Drucker (1969) book 'The Age of Discontinuity', this view has gained traction in the past 20 years (e.g. Cohen & Levinthal, 1990; OECD, 1996). Proponents of this view of the firm focus on knowledge as the competitive asset, and emphasize the capacity of the firm to integrate tacit knowledge (Grant & Baden-Fuller, 1995; Conner & Prahalad, 1996; Mowrey et al., 1996). By a firm adopting this approach to strategy, they acknowledge that competitive advantage has a level of dependency on the value of knowledge developed within the social and human elements available to them and, thus, identifies intellectual and the generation of knowledge and knowledge based assets as a fundamental strategic priority and a key source of competitive advantage.

Generating knowledge resources are an imperative for innovation performance. As mentioned previously, the contemporary competitive environment is characterised by rapid changes, sophisticated competition, (D'Aveni et al., 2010; Porter 1990) and quick replication of competitive actions. Additionally, the mobility of knowledge workers across companies and industries results in a level of knowledge heterogeneity (Knott, 2003). Firms need to develop efficient techniques to ensure that knowledge acquisition activities are competitive and fill deficiencies in the stocks needed to fuel innovation activities required within the market. In contrast to the resource based view, the knowledge based view acknowledges the potential for acquiring knowledge beyond the remit of the organization. By shifting the focus from internally held and protected generic resources, the knowledge based view provides an alternative explanation to how firms might acquire external expertise.

The knowledge based view has not been as widely adopted as the resource-based view for strategy development. While it is widely accepted that knowledge can provide organizations with a level of resources necessary to compete, often knowledge is viewed as a generic resource and as a supporting activity that functions along-side the other resources the firm may hold. This assumption also emphasises that resources must be held internally and protected from replication. The knowledge based view argues that acquisition of knowledge should be the core

priority for firms, in so much that this acquisition is a core part of an organizations strategy This is especially important among firms that emphasises the process of innovation so to allow a culture of learning (Grant, 1991).

2.2.5 Section Discussion

This section discussed the context and importance of innovation activity by firms, as well as the many factors that impact the approach adopted by an organization in the development and management of their innovation strategies. Innovation activities are necessary to fuel competitive actions within dynamic markets, but there are several complexities that inhibit the sustainable development of knowledge resources. Generating the knowledge stocks necessary to stimulate innovation activities is resource intensive. While it has long been acknowledged that an abundance of knowledge resources to stimulate innovation activities, there are several underlying assumptions that may impede a firm's ability to acquire them in the same fashion as the generic resources identified by the resource based view of the firm.

The resource based view (as a theoretical basis for knowledge activities) falls short to explain or forecast innovation performance when the context of the activity requires the acclimation of external knowledge. The socially complex nature of knowledge and resource identification impacts the managerial approaches to the development of incremental or radical innovation outcomes, and why it is necessary for the literature to transition to a knowledge-based view. The knowledge based view emphasises that firms must adopt new managerial philosophies to develop the intellectual resources and capabilities to extend their resource-base beyond the boundaries of the firm. It argues that the resource based view falls short to appreciate the value of resources or capabilities that the firm does not, or will not, have direct control of. However, this is only one aspect in the theoretical shift necessary for understanding the acquisition of external knowledge stocks through open innovation.

Internal resources needed to provide a sufficient breadth of innovation activities to retain or accrue competitive advantage, firms seek to gain access to potential opportunities that may lie beyond the boundaries through developing inter-organizational relationships in an activity that has been termed as 'open' innovation in the literature. Through pursuing a collaborative arrangement, firms can access the capital intensive resources necessary in order to gain time efficiencies "to new technologies or new markets, to benefit from economies of scale in joint research and/or production, to tap into sources of know-how located outside the boundaries of the firm, and to share risks for activities that are beyond the scope or capability

of a single organization” (Powell, 1990: 315) and advance their internal capabilities (Sivadas & Dwyer, 2000; Lichtenthaler, 2008; Volbedra et al., 2011). The firm may develop the capability to access resources that may be available within their network of inter-organizational relationships and can potentially innovate to a much larger extent (Chesbrough, 2003, 2007; Sisidoya et al, 2013). The firm may also find opportunities to exploit and spin out internally developed technologies amongst partners. However, the development of an appropriate strategy must consider both the inflows and outflows knowledge stocks between partnering organizations. The knowledge based view has also not been widely adopted and can be seen to undermine traditional approaches to protecting trade secrets (Foss, 1996; Rivkin, 2006). However, this implicit basis remains overlooked in some of the open innovation management literature (particularly that which identifies universities as potential innovation partners). The next section will discuss open innovation business models.

2.3 Open Innovation Business Models

The competitive dynamics in many industries have begun to threaten the viability of innovation strategies that are focused inwardly to the firm. Companies are facing challenges in developing the internal resources needed to provide a sufficient breadth of innovation activities to retain or accrue competitive advantage (Chesbrough, 2003; Doz & Hamel, 2005; Bingham & Spradlin, 2011). Firms must seek to gain access to potential opportunities that may lie beyond the boundaries through developing inter-organizational relationships. Rather than operating in isolation, firms connect with external knowledge sources, such as universities, to develop new ideas and technologies. This activity has been termed as ‘open’ innovation in the literature.

This section of the chapter discusses the concept of open innovation business models. It begins by providing a context of open innovation business models through a discussion of the traditional ‘closed’ innovation versus contemporary ‘open’ (or relational models) of innovation activity. While there are clear benefits in effectively connecting with external pools of knowledge, many firms might struggle to develop external relationships required to meet the high innovation performance and outcomes expected in this alignment. A significant factor impacting this alignment, especially within the university-business relational context, lies within the different forms of open innovation based on the objectives and resource needs of the organizations; e.g. inbound, outbound or coupled (Gassman, Enkel, & Chesbrough, 2010). The knowledge resource deficiencies (or surplus) of a focal firm determine the format of the

approach taken. However, the potential for collaborative innovation between a university and a business has been relatively overlooked within the literature.

The partners for open innovation are diverse, and often they possess significant levels of diversity in terms of operational and functional characteristics. It is beyond the remit of the thesis to discuss the variation between all of the partner types, but it is important to illustrate how varying partner objectives impact the business model adopted for open innovation relationships. This section discusses the commonly used business models for open innovation activities. As will be demonstrated, universities are typically cited as inbound open innovation sources but this approach may undermine the capability for collaborative work and mutual benefit. This complicates the alignment and potential for innovation development, as there are many overlooked social and social relational complexities that contribute to the process of new knowledge generation. Therefore, the context of universities as potential innovation partners provides a compelling backdrop to understanding how relational context impacts open innovation activities and organizational objectives.

Managerial assumptions regarding the business model to employ for university-business relations may impeded the development of open innovation in practice and in the literature. This section re-illustrates the impact of the resource-based view and why managers may be apprehensive to ‘opening’ up for knowledge exchange. There is an assumption of opportunism and much of the open innovation literature implicitly assumes market mechanisms (e.g. contracts and hierarchies) as a sufficient governance mechanism. This final section will then discuss the widely-adopted transaction cost economic approach to organizing external relationships, and the impact this approach has on value creation and innovation outcomes.

2.3.1 Defining Open Innovation

The act of open innovation is typically contrasted with the (traditional) closed models of innovation, in which development activities remain internal and managed by the focal firm (Chesbrough, 2003; Huizingh, 2011; Felin & Zenger, 2014). Traditional models of innovation (e.g. traditional R&D) has been internally focused, whereas the underlying logic that significant investments to the R&D department awarded the firm with knowledge advantages over their competitors and was to be protected (Kline, 2006; also, see Hutson & Sakkab, 2006 & Rohrbeck et al., 2009; Herzog & Leker, 2010).

An open innovation model provides a framework for organizations to acquire and deploy knowledge stocks as an economic, tradeable, and exploitable good, which may present the opportunity to leverage internally and/or externally capabilities and/or developed technologies into meaningful, unique and commercially viable innovations (Chesbrough, 2003; Perkins, 2008; Ahmed & Shephard, 2010; Huizingh, 2011; Sisodiya et al., 2013). It can be used to inform a variety of business activities, although the concept is most frequently applied in the context innovation activities surrounding new product development. Through the development of links with external partners, firms may can access new and exploitable knowledge from a wide range of external sources whilst also leveraging internal activities (von Hippel, 1988; Powell 1990; Brown & Duguid, 1991; Chesbrough, 2003; Ketchen et al. 2005). This allows a firm to advance and generate new product development more quickly and in a more sustained fashion (Reiner, 1989; Sisodiya et al. 2013).

Although the concept of connecting with external entities for resources beyond the means of the focal organization is not a new phenomenon, the application of an umbrella concept of open innovation has only defined this range of activities within the past 10 years (Chesbrough, 2003). Open innovation has received considerable attention as a solution to the resource constraints experienced in the contemporary competitive landscape (Giannopolou et al., 2010). There are considerable efficiency and cost benefits that *may* result when a firm is capable of combining internally generate intellectual property and externally gathered input and expertise (Dittrich & Duysters, 2007; Sisodiya et al. 2013) This knowledge sharing activity is a combination of external (partner) ideas with internal (firm-level) capabilities which serves to benefit through a high level efficiency of marketable idea are generation and thus, the exploitation into economic outcomes (Keupp & Gassman, 2009).

Recent studies have shown that organization frequently associate several risks with the pursuit of open innovation, such as difficulty in aligning with partners, loss of knowledge, higher coordination costs (both in time and finance), a loss of control and higher complexity (not only in managing the external relationship but also in sustaining daily processes) (Enkel, Gassman, & Chesbrough, 2009; Dahlander, 2010; Chesbrough, 2013; Reingold, 2013;). Recognizing both the benefits yet risks, open innovation seekers have begun to use the assistance of intermediaries to facilitate open innovation (Hossain, 2010). However, it remains clear that the rewards of open innovation are not guaranteed.

The potential for firms to underestimate or be oblivious to the potential complexities of open innovation is in fact widespread. Many firms have found that connecting with open innovation partners can present unforeseen challenges and does not always guarantee

successful outcomes (Robertson et al., 2012; Ye & Kankanhalli, 2013). For example, studies report that incumbent organizations that have a long-standing history of producing innovation within the remit of a closed innovation strategy will tend to react more favourably to internally developed knowledge and are more likely to reject competing external ideas, resulting in the ‘not invented here syndrome’ (West & Gallagher, 2006; Ye & Kankanhalli, 2013; Felin & Zenger, 2014). Firms that have made legacy investments in the development resources and knowledge stocks tend to over-invest in ‘safe bets’ and are likely to underestimate the value of external relations (Makadok, 2003) and can underestimate the effectiveness of innovation activities by other firms (Debruyne et al., 2002). External ideas that have been acquired in the absence of relational capabilities may be rejected within the organization (Atuahene-Gima, 2005). Stated differently then, existing firms with longstanding traditions in closed innovations may underestimate the complexity of operating inter-organizational relations for open innovation (Felin & Zenger, 2014) because the context is in fact far removed from solely a resource dependence model.

The effectiveness of an open innovation strategy is dependent on many variables, and how outcomes and effectiveness is measured via differing performance indicators; such as financial efficiencies, volume of technological advancements, and satisfaction (Hill & Rotharmel, 2003; Cheng & Huizingh, 2010; 2011). Additionally, the potential for benefits to emerge from resource sharing among partners is impacted by a variety of organizational factors, variations in strategic intentions, and how relationships are managed (Gupta & Govindarajan, 1986; Tsai, 2001). Some others have associated the role of openness in explaining performance (Laursen & Salter, 2006). A primary concern is alignment of intention between partners to acquire and acclimate knowledge obtained from their external relationships, as well as their intention to extend their own resources or knowledge in appropriate manner (Bourdeau & Lakhani, 2009; Enkel et al., 2009). Yet, the relational complexities and the difficulties in managing social aspects between firms are rarely appreciated within the open innovation literature that identifies universities as potential innovation partners (Chesbrough, 2003, 2006; BIS, 2011, Bingham & Spradling, 2011), indicating a common assumption that knowledge can be governed in market type transactions.

The variance between partners’ objectives in open innovation relationship directly influence the strategies developed. At the forefront of developing open innovation partnerships, the motives for knowledge resource flows and the potential outcomes must be aligned between partnering organizations. The next section will discuss how the direction of knowledge flows impacts the relational design.

2.3.2 The Direction of Knowledge Flows and Open Innovation Strategies

The concept of open innovation is to make purposeful use of the inflows and outflows of knowledge (Chesbrough, 2003, 2006). The resource deficiencies and the knowledge acquisition motives of the firm define the format in which inter-organizational partner might be organized, such as the business model it adopts, the types of partners sourced, and the managerial governance necessary (Bourdeau & Lakhani, 2009; Keupp & Gassman, 2009). There are various forms of open innovation business models, which are typically determined by the flow of resources across organizational boundaries and the firm's knowledge sharing or acquisition motives, exploration, or exploitation strategies (March, 1991; Herzog & Leker, 2006). The selection process often begins with finding the appropriate source that aligns with the organization knowledge resource (deficiency or surplus) objectives.

There are many different types of external partners that can be utilized to gain external ideas in open innovation relationships, e.g. SMEs, venture capitalists, crowd-sourced, lead users, end consumers, universities, etc (Keupp & Gassman, 2009). Research supports that performance and outcomes of these relationships are impacted by a wide variety of contextual factors, e.g. strategy orientations, goals of innovation, environmental factors, partner selection, intellectual property, and mutual benefit (Wallin & von Krogh, 2010; Cheng & Huizingh, 2014). While it is beyond the remit of this thesis to discuss each of these partner characteristics in turn, it is essential to define the various modes of knowledge transfer to elaborate upon. As will be shown, the complexities associated with the alignment between partners are many (Laursen & Slater, 2006). Within the open innovation research streams, there are generally three different approaches to the processes adopted by organizations; inbound, outbound, and coupled process (Gassman, Enkel, & Chesbrough, 2010). This section provides a discussion of these three different streams of literature and the impact that they may have on partner selection, strategy development, and business models.

2.3.2.1 Inbound Open Innovation

There is a large emphasis in the literature on the potential benefits for open innovation business models to provide firms with an opportunity to acquire external knowledge input and resources into their innovation base from a variety of potential partners. Recent reports reveal that firms engaged in open innovation are most likely to engage in the act of inbound open innovation over and above the other modes (West and Gallagher, 2006; Chesbrough, 2013). This approach is often designed to include various external expertise into the innovation

process; e.g. crowdsourcing, customers and lead users (von Hippel, 2001), suppliers, vendors, research expert, and universities (Cohen & Levinthal, 1990; Chesbrough, 2006). Utilizing this approach, companies aim integrate external knowledge into the organization's internal operations. As such, universities are frequently cited as one of the frequently pursued sources of inbound innovation (Franhoufer, 2013, *please refer to figure 1*). This format places a special emphasis on the exploration process as a means for enhancing their innovation process (Laursen & Salter, 2006) in which there are several different modes of acquisition strategies.

The inbound form of knowledge acquisition may present challenges in integration due to the alignment to current held knowledge stocks. Firms that have a history of developing products, services, core technologies, prefer incremental improvements over and above disrupting these long-standing products (Utterback, 1994; Chandy & Tellis, 2000; Chandy et al., 2003;). Incumbent firms become more wedded to their internally developed technologies rather than accept the external idea and a tendency to react more favourably to internally developed knowledge, resulting in rigidity and the rejection of external acquired and competing ideas (Makadok, 2003; West & Gallagher, 2006; Ye & Kankanhalli, 2013). The organization must develop techniques for complementing internal R&D by absorbing appropriate external knowledge relevant to their internal activities (Cohen & Levinthal, 1990; Ye & Kankanhalli, 2013). The main challenge is to find managerial practices, processes and culture that is open to exploring external ideas and developing the capabilities necessary for integration (Denning 2005; Sirmon et al., 2010).

2.3.2.2 Outbound Open Innovation

Outbound open innovation offers a promising solution for organizations that hold excess patents (or knowledge stocks) that may not align with the core focus of the firm (Vanhaverbeke et al., 2008). This form takes internally developed ideas to market through licensing out patents, corporate venturing activities, licensing, sale of intellectual property, or in the development of spin out organizations. It holds promise for firms looking to develop unique streams of revenue without pursuing the internal development risks and costs (Lichtenthaler & Ernst, 2007). This also allows the firm the opportunity to recover lost investment for patents that are not proving to be useful to the firm.

However, outbound open innovation is far less utilized within large organizations. A recent report commissioned by the Fraunhofer Institute (2013) suggests that while 87% firms

are engaged in open innovation, only 8% of the projects they work on have an outbound element. This is in comparison to the inbound open innovation activities, which contribute to 35% of firms' projects (Chesbrough, 2013). Additional risk remains in the inability to identify or overlook potentially profitable innovations or the disruption of the market, e.g. Kodak, Xerox (Christenson, 1996). The potential risk is that internally developed innovations, which may undermine current objectives, have potential to create new markets and compete with the core business.

2.3.2.3 Coupled Open Innovation

The coupled process of open innovation focuses on the co-development of innovations and the potential for reciprocated knowledge flows between partners, and has received less attention within the literature. A coupled process of open innovation has received less attention in the literature than the inbound and outbound modes. This focus emphasises the potential for synergistic benefits between similar and non-competing organizations through deeper integration (Enkel, et al., 2009; Felin & Zenger, 2014) or by accessing innovation communities. Through collaboration, alliances, joint ventures, and partners can achieve high levels of efficiency for commercializing new technologies, but this format requires relational development and commitment from the partnering firms.

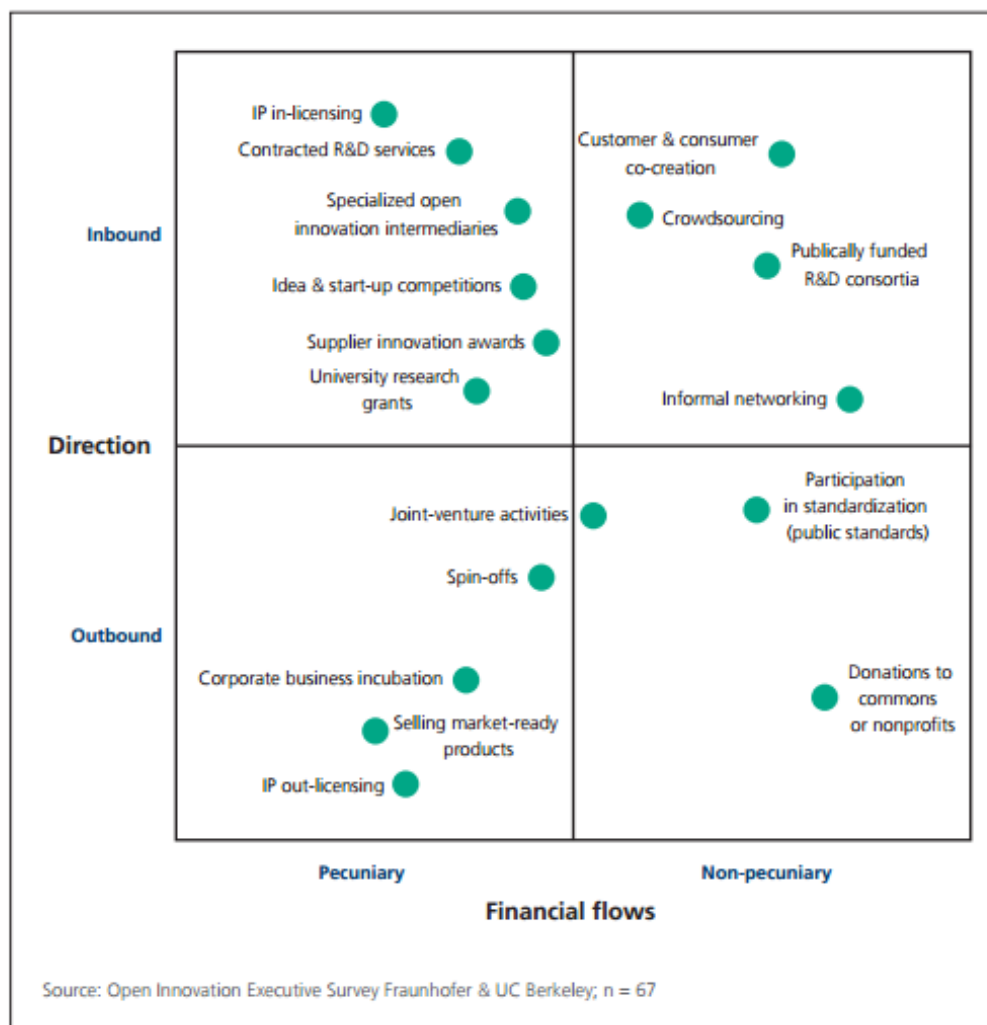
The route from advantaging on collaborative opportunities to the actual generation of valuable outcomes is fraught with difficulties. As mentioned previously, the process of innovation is largely contingent upon the careful coordination of complex human and social elements that must be aligned and managed to access, release, and generate the knowledge necessary for innovation outcomes (Rodan & Gallunic, 2004; Nonaka, 1994; Kogut & Zander, 1992). For relationships to be effective many conditions and contingencies must be managed and orchestrated simultaneously, including organizational culture, objective, methods of operation, etc.

Effectiveness of the knowledge transfer is also dependent on the complexity of the knowledge transferred and the ability for the firm to identify opportunities within it (Cohen & Levintal, 2006; Hughes et al., 2014). Yet, there is a lack of empirical examination into how an open innovation relationship between a university and a business can be structured, the content of the knowledge diffused, and the development behaviours interact to determine the quantity and quality of value creation from relational endeavours. There is need for research to reveal how partnerships of this nature might be initiated, effectively developed, maintained and

enacted to the extent that either party would acquire external knowledge or resources (relevant to innovation and value creation) in the absence of immediate returns.

This thesis focuses on understanding how a coupled process of open innovation can be enacted between a university and a business for mutual benefit and value creation. The alignment and functioning of a collaborative research partnership, such as this, is characterized by multi-faceted alignment and management issues, many of which may be specific only to local conditions. This form of relationship is particularly interesting to study because effectiveness, satisfaction, and mutual benefit for either party must be coordinated and aligned in a way that serves various economic and non-economic motives and incentives.

Figure 1 - Classification for Modes of Open Innovation



The next section will consider the context of university management, as well as the streams of research conduct in this vein of open innovation literature and the factors that have potential implications in strategy design. As will be illustrated, the relational complexities of

university-business partnerships include a wide array of external pressures. This compounds alignment issues that are typically associated with strategic partnerships.

2.3.3 Universities as Open Innovation Collaborates

Universities are frequently cited within the open innovation literature as potential partners in the knowledge acquisition process (Chesbrough, 2003; Perkman & Walsh, 2007; Gassman, Enkel, & Chesbrough, 2010; Metcalfe, 2010). Historically, university laboratories have been considered a source of the front end of basic science exploration for firms seeking external knowledge inputs and expertise. As such, businesses around the globe have connected with universities to resolve knowledge complexities faced by their organizations since the advent of commercialized applications for scientific research (Rothwell, 1994). However, the focus on the *potential* opportunities for universities and businesses to combine research efforts and to collaborate has increased in importance in recent years (Metcalfe, 2010; Wilson Review, 2012; BIS, 2012).

Universities have long been considered the backbone of national innovation and competitiveness, either through the development of national human capital or the value of research activities. However, a focus on this trend has significantly increased in prevalence since the bottom quarter of the 20th century (Slaughter & Leslie, 1997) with nations around the globe questioning the viability of economic conditions and constrained resources has inspired several governments to develop policy initiatives to encourage universities and organizations to collaborate (e.g. Bayh-Dole Act, 1980; Wilson Report, 2012; BIS, 2012).

Governments are eager to develop domestically more efficiently produced 'innovation' assets through various forms of intervention and stimulation policies. Policymakers, scholars, and managers recognizing that this form of collaboration offers a promising solution to the issues surrounding strained economic resources and innovation activity for nations (Rijnsoever et al., 2008). Interventions, initiatives, and incentives serve as techniques that are not only aimed to encourage gross national product growth and economic prosperity (Porter, 1990), but also to ensure public resources are being used to provide the highest levels of societal impact (REF, 2014; ONS, 2016). It has been recognized that sharing knowledge resources between a university and a business has the potential to offer scope efficiencies in this vein. Additionally, some of the knowledge generated within university laboratories has commercial potential but may lack market knowledge or the supply chains necessary to translate inventions to viable

innovations (BIS, 2012). A university and a business could, potentially, align to address resource deficiencies on either end.

Although it is quite clear that the overarching objectives of this form of relational linkage is to generate commercially viable innovations, there are significant differences (e.g. various exogenous pressures, stakeholders, operational objectives, research focus, outputs, etc.) that impact how a university and a business could achieve mutual benefits (Rosenberg & Nelson, 1994). There are significant organizational differences are often understated within the literature. While research has focused on the factors that contribute to the effectiveness of university technology transfer office, citing that performance is related to the offices capability to engage legal context and appropriately manage intellectual property. There has been less work that discusses the potential for misalignment of cultures and objectives within this partnership (e.g., methods of operation within and towards relationships, the development of trust, opportunity identification and exploitation therein) (Klawe, 2011; Cheng & Huizingh, 2014).

Evidence of high failure rates and reports of general dissatisfaction indicate that this form relational linkage between partners warrants a need for further conceptual development (Bruneel, D'Este, & Salter, 2009) and practical applicability. Even the very recent Wilson Review of Business–University Collaboration (2012) and the previous Lambert Review (2003), both highly influential reviews commissioned by the U.K. Government, fail to appreciate the potential complexities of this relational exchange. Clearly, there are significant potential benefits for the organizations and university to effectively reap value from open innovation relationships, but there is a significant risk to the vitality and performance of this relational design due to the presence of under-appreciated complexities. In view of the identification of university partners as important supply chain members for businesses (The Wilson Review, 2012).

This section will discuss current trends in the development of (open) innovation policies that impact universities and the institutional pressures they are facing to reveal their current desire for opening for commercial research. As universities are typically viewed as public institutions, and are impacted by a wide range of political and societal stakeholders, a review of current policy agendas and the will aid in developing a stronger basis for understanding the complexities of planning and managing a coupled process of open innovation with academic partners. The section will then review the debate surrounding the purpose of academically developed knowledge and the impact that this may have on intrinsic motivations for

universities. The final section will reveal the current research on universities as open innovation partners.

2.3.3.1 The Role of Academia in the UK National Innovation Policy

Universities are public institutions, and are designed to respond to a wide variety of external changes and the demands of societal trends (whether through scientific pursuit or updating educational agendas). The UK Government's innovation policy 'Strategy for Sustainable Growth' (BIS, 2010), as well as the 'Innovation and Research Strategy for Growth' (BIS, 2011a) requests greater responsibility through emphasising benefits of this form of collaborative work with commercial partners (e.g. input into innovation activity, stimulating economic growth). The commercialization of academic research and scientific knowledge might enhance economic and national competitiveness within many industries (Salter & Martin, 2001; Melese, 2009; Metcalfe, 2010), however there are concerns on how this will impact the universities core objectives (Slaughter & Leslie, 1997). This agenda places significant pressure on universities as they are now viewed as a means for economic growth rather than for the generation of knowledge for societal benefit (Hagen, 2002). This additional focus presents considerable challenges to university resources and operations (Fontana, Geuna, & Matt, 2006).

The research sector in the UK is globally recognized for high quality outputs and ranks second in the world following only the US and "among the G8 countries it produces the most publications per £ of public funding" (REF, 2014). The Higher Education Institutions (HEIs) in the United Kingdom are supported through a variety of channels, however, traditionally public funds have been used to support the associated costs of learning, teaching, and research (HEFCE, 2007). HEIs and the research fund allocations have been primarily regulated through a division of the Department for Business, Innovation, and Skills (BIS) called the Higher Education Funding Council for England (HEFCE).

Traditionally, HEFCE assessed HEI quality with regards to the international quality and rigour of the publication as well as the extent of citations however this former system faced criticisms and in 2006 there was a shift in the assessment techniques utilized in decision making (REF, 2014). Political changes under the Labour Party in 2008 called for updated measures to assess the quality and usage of research outputs that were funded by public monies. The updated assessment, called the Research Excellence Framework (REF), now recognizes the

potential economic and societal impact that HEI research has beyond academia. New metrics have been enacted to improve the accountability of HEIs ability to provide wider public benefits for research conducted with public funds. HEIs and the fund allocations have been primarily regulated through a division of the Department for Business, Innovation, and Skills (BIS) called the Higher Education Funding Council for England (HEFCE). The HEFCE is then split divisionally across the various research councils that have disciplinary focuses; e.g. the Economic and Social Research Council (ESRC), the Engineering and Physical Science Research Council (EPSRC), and the Biotechnology and Biological Science Research Council (BBSRC) are just a few examples. The expectation is that universities not only reflect academic excellence in the quality of their publications but also to provide evidence of the long-standing benefits of the knowledge generated.

The updated assessment, titled the Research Excellence Framework (REF), recognizes the potential economic and societal impact that HEI research has beyond academia (BIS, 2012). New metrics have been enacted to improve the accountability of HEIs ability to provide wider public benefits for research conducted with public funds (REF, 2014). However, the changes to this funding structure placed constraints on the research income into the universities. An interview participant from this study stated:

Historically, most of our research income came from the government through research councils. But, the spending that they had available sort of topped out at around 2008. So, it's been on a slow decline since.

The expectation is that universities not only reflect academic excellence in the quality of their publications, but also to provide evidence of the long standing social benefits of the knowledge generated and within their operation through encouraging partnerships with the community or organizations (BIS, 2011; Lambert Review, 2003)

HEFCE's new accountability measures have inspired a rejuvenation of strategic objectives for many universities across the United Kingdom (Christensen & Eyring, 2011). Universities are now faced with the intense pressures of not only achieving the IMPACT agenda but also through the greater responsibility to independently source revenue for research activities (Slaughter & Leslie, 1997, D'Este & Patel, 2007; D'Este & Iammarino, 2010). The IMPACT agenda offers a new measure for universities to compete amongst each other for public funding, ranking, and reputation. However, reports reveal that the performance based research assessments illustrate that the competition for prestige creates powerful incentives for

universities and states that these assessments will not contribute to the economic relevance of research (Hicks, 2012). These new measures have also placed varying degrees of resource pressures across disciplines throughout the university setting that may struggle to find external sponsorship. Additionally, the public funding for fundamental sciences has become much more competitive within the university landscape (Auranen & Nieminen, 2010). There are also considerable pressures for the individual researchers to design complex projects that meet requirements relevant to account for impact, and has left some to believe that these new measures have been developed in favour of applied science and at the expense of basic scientific research and academic freedom (Behrens & Gray, 2001; Nemetz & Cameron, 2006).

2.3.3.2 The Impact of Funding Structures

There is a strong trend within the university-business literature to focus on the impact of decreased public funding and the effects of private funding on academic research. There has been considerable research conducted on the complexities of funding structures and the performance of university-business relationships (Benner & Sandstrom, 2000; Park & Leysdroff, 2010; Hicks, 2012). A widely-adopted model for funding structures is called the triple helix, and is the one most frequently utilised within the United Kingdom (Benner & Sandstrom, 2000; Etzkowitz & Leysdesdroff, 2000). This is a matched funding approach, in which research is funded through a combination of public, private, and university investments (Just & Hoffman, 2009; Musico et al., 2013). Designed by the Fraunhofer Institute in Germany, the triple helix funding structure aims to share responsibility across collaborative partners. However, the process of negotiating the terms of investment, ownership, and the organisation of a research project often results in complexities in defining project expectations. This has the potential to add stimulate dissatisfaction if the terms are not negotiated appropriately. As a response to these pressures, the UK government has developed institutes that aid in these early negotiations, for example the Centre for Process Innovation (CPI) focuses on developing regional partnerships. However, the primary focus of these intermediaries is in aiding organizations in addressing the complex nature of the formal mechanisms, such as the compliance and finances rather than on developing the informal mechanisms relationship for knowledge transfer.

There are variances in the ways funding structures are adopted across the globe, yet recent research reveal that there is not a direct correlation between financial incentives and the research outputs; and raises the question as to whether policy makers should emphasise financial incentives (Auranen & Neiminen, 2010). Research also suggests that government

policy plays a role in encouragement and joint R&D projects encourage industry to interact and willingness to engage with universities (Lee & Win, 2004). As such, research vouchers have been issued by the Technology Strategy Board as well as collaborative schemes through the Research Councils (e.g. Innovate UK, EU Horizon 2020) that encourage open partnerships to emerge between incumbent organizations, SMEs, universities, and research consortiums. Over 40% of businesses state that universities lack the internal resources to contribute to this form of interaction, while over 30% of academics cite that this form of relationship presents too much bureaucracy and insufficient rewards (Hughes & Kitson, 2013). As the funding structures increase in complexities the expectations and relational dynamic increase as well. The capability of the university to manage diverse expectations significantly impacts whether value will be achieved.

2.3.3.3 Composition of University Knowledge Transfer- Pure Versus Applied Science

The variance in value realization for each of these parties and how mutual benefit might be achieved indicates a potential for conflict that hitherto lacks clarity. For example, there are important distinctions between the pursuits of academic and commercial research. Academic research, conducted within the remit of university laboratories, typically has a primary focus towards expanding knowledge-bases through theoretical development, whereas commercial research is aimed towards the pursuit for answers to specific problems or technological advances (Rosenburg & Nelson, 1994; Lee & Ling, 2007). These variances in anticipated knowledge generation and research objectives suggest that there is a significant risk for complexities in the alignment of organizational cultures and management practices; e.g. opportunity identification, definition, creation, coordination, and outcomes (Kogut & Zander, 1994). This leads to a broad assumption that university research is best suited to provide generic technologies or widely distributed pure science that can emerge from fundamental research projects (Ahmed & Shepherd, 2010).

There are debates within the literature regarding the impact of this form of relational exchange will have on the university knowledge base (Rosenberg & Nelson, 1994; Godin & Gingras, 2000). Many are concerned about the dilution of the pure scientific knowledge base, citing that this form of relationship may result in less publications as academics become more focused on meeting commercial objectives (Guená & Nesta, 2006). While academic vitality has been measured in terms of publications, there are concerns that this form of collaboration might result in a loss in academic freedom (Behrens & Gray, 2001). For instance, research by Goldfarb (2008) indicates that the criteria for industrial funding mechanisms does not

contribute to a career in academia. However, research by Looy et al. (2004) indicates that entrepreneurial academic activities and industrial collaboration does not hamper the quality of the academic publications and increases the volume, as more resources are devoted to the relationship the relationship becomes more significant.

In response to this controversial debate, much research and practical guidance suggest that this form of relationship should be enacted merely as a formal transfer between organizations through licencing or a consultancy project (Chesbrough, 2003; Melese et al., 2009) and overlooks how to manage the social complexities for co-developed and collaboration knowledge exchange for innovation development. Generally, firms participate in this form of partnership to gain access to upstream knowledge bases rather than technologically specific product knowledge (Feller, Ailes & Rossener, 2002). This indicates an underlying assumption that this type of relationship link is of a transactional nature guided by formal mechanisms. However, there are many opportunities for a university-business relationship to engage on much deeper level and create synergies that are overlooked within the literature. The next section discusses the various forms of university-based industrial activities and the different opportunities for businesses to engage.

2.3.3.4 University Innovation Activities

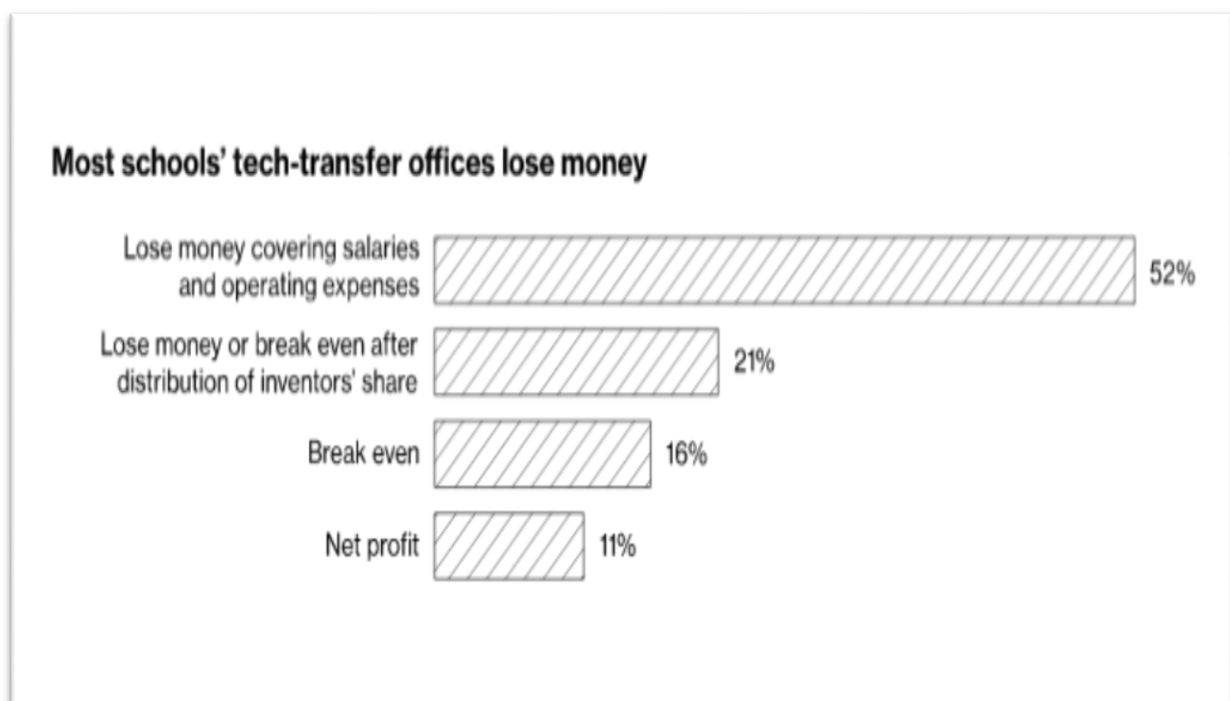
Universities have been engaged with the commercialization of innovation since the end the Second World War (Rothwell, 1994), however the focus has shifted since the late 1970s as developed a greater interest to licence intellectual properties and expand their research income (e.g. Bayh-Dole Act 1970 and the education reforms under Margaret Thatcher). As such, technology transfer offices have become a standard element of a university's structure. The technology transfer offices engage in a wide range of commercial activities for the university and the academics, and is typically viewed as a support service. The activities that these offices engage in range from intellectual property and patent protection to spin out activities. In addition, these offices must can manage the various institutional pressures (e.g. legal, political, and organizational) whilst also sourcing and establishing business relationships that are appropriate for the range of commercial activities in which they are engaged. Often, these relationships are further characterised by complex funding structures and have varying objectives to fulfil the requirements of research councils.

The basic objective of the technology transfer office is to enhance and support the intellectual property generated at the university (Siegal et al., 2004). There is a growing body

of literature on the effectiveness and role of technology transfer offices and how to best organize them for high performance (see Plan & Siegel, 2006), with some reports stating that while the patenting activities by universities have increased it has yet to generate a sustainable source of revenue (Shane, 2004). Many researcher attribute the complexities of funding structures. However, some universities are more effective than others in their commercial activities (Link & Siegel, 2005).

A recent inquiry commissioned by the United Kingdom Business, Innovation and Skills committee revealed, that regardless of the funding invested, innovation performance and outcomes has not improved (Parliament, 2014). Merrill et al., (2016) reports the under-performance that most university based technology offices fail to achieve a full return on investments (please refer to figure 3). They utilize the example of Stanford University. Since the development of the tech transfer office in 1970, Stanford has produced 10,000 invention disclosures and only 3 patents have resulted in multi-million dollar deals (Merrill et al., 2016) As can be seen, value creation and disseminating knowledge in a sustainable and effective way, across this type of organizational boundaries, remains a challenge.

Figure 2 - Overview of Tech Transfer Performance (Source Merrill et al., 2016)



There are various ways and multiple underlying factors for the variety of engaging with academic work ranging for contract to consultancy to co-developed innovation, and there are many complexities in organizing the contractual, legal, and managerial factors to exchange.

There is an emphasis importance of screening, searching, and signaling in university-industry (Fontanna, Geuna, & Matt, 2006). Additionally, the size of the organization matters and the willingness to engage in the screening of publications and involvement in public policies (Fontana, Geuna, & Matt, 2006). In fact, research even suggests an individual academic's personality has a larger impact on project performance and interactions rather than the characteristics of the university (Gulbrandsen & Smeby, 2005; D'Este & Patel, 2007).

A review by Perkman and Walsh (2007) indicated that the extent of relational involvement contributes to value creation for firms in alternative ways. Please see figure 3 for the typology they have proposed.

Figure 3 - Extent of relational involvement (Source Perkman and Walsh, 2007)

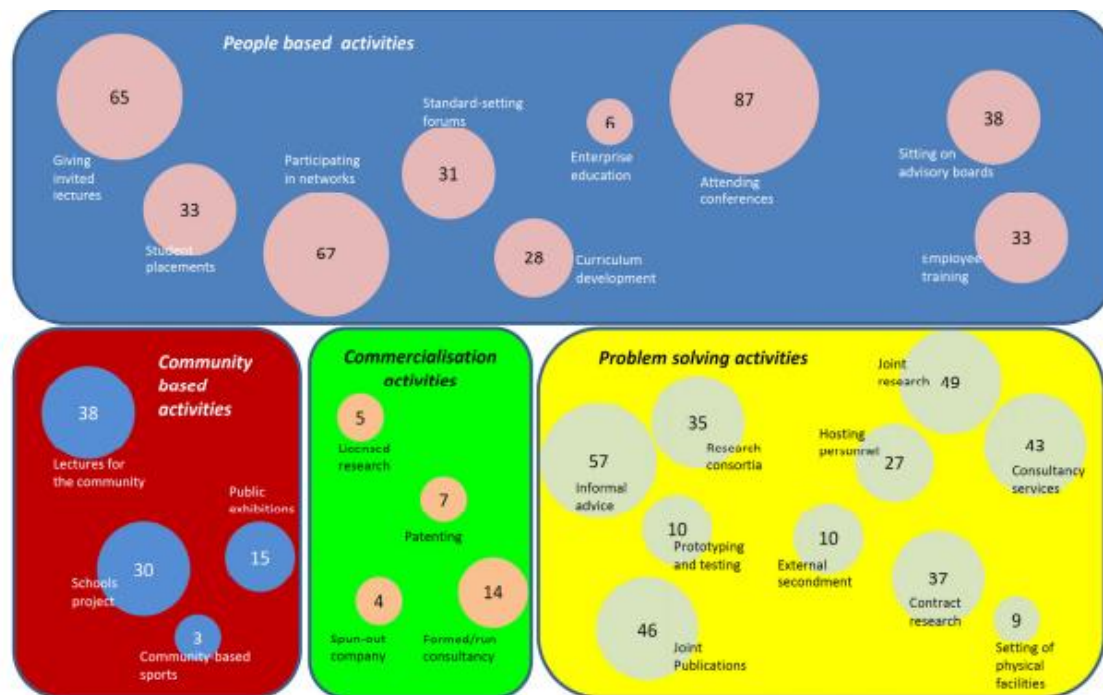
High: relationships	Medium: mobility	Low: transfer
Research partnerships	Academic entrepreneurship	Commercialization of IP (e.g. licensing)
Research services	Human resource transfer	
Use of scientific publications, conferences, and networking (can accompany all forms)		

With promises of spin out companies, sales/divestures, and licensing, universities hope to generate new streams of revenue (Melese et. al, 2009), some researchers even argue that universities need to collaborate with industry to receive high performance outcomes (Balconi & Laboranti, 2006). Recent evidence reveals that greater collaboration between universities and businesses stimulate R&D activity and growth within an industry, and show that joint R&D projects encourage industry to interact and willingness to engage with universities (high commitment) and that government policy plays a role in encouragement (Lee & Win, 2004).

In the process of transferring technology between a university and a business, some research has evidenced that absorptive capacity plays a role (McAdams et al., 2009) and emphasising the importance of entrepreneurial behaviour for these department (Shane, 2005). Stating the cognitive effects and normative effects of tech transfer (Etzkowitz, 1998) Indicating that certain human and social elements play a role, and the need to address the barriers in university-business relations (Bruneel, D'Este, and Salter, 2009). However, there has not been much acknowledgement within the literature that improving business activities through academic engagement is not always limited to intellectual property. In a recent review of the

nature of university-business engagement, the researchers identified a distinction between people, community, commercial, and problem-solving activities (Hughes & Kitson, 2012). While this analysis cover a breadth of activities, it reinforces the notion that business interactions are not limited to interactions in the technology transfer office.

Figure 4 - Academic External Interactions



Source: Hughes and Kitson (2012)

The work in this area focuses on the potential for spin out activities or technology and much of the research has overlooked the contingencies impacting the relational behavior of the people collaborating within the knowledge exchange. There is a common assumption that the effectiveness of this form of relational exchange is dependent upon the final stage of ‘exploitation’, yet the interactions between the people, from either side of the relationship, are contingencies that are required for developing the relationship and sharing the knowledge has been overlooked.

2.3.3 Section Discussion

This section reveals the complexities associated with establishing a relationship with a university. One of the most widely researched areas University-Business relationships focus on the complexities that surround policy making for funding mechanisms and ownership issues (Etzkowitz et al., 2000) and, thus, it is generally discussed in the form of intellectual property and licensing rights. The funding mechanisms are often developed through a combination of

private and public investments, and much of the research in this area is focused on how policy can be designed to stipulate a fair exchange. As the research tends to emphasise the financial mechanisms and ownership issues, the literature tends to adopt implicit assumptions of market-based mechanisms as the sufficient form of relational governance (e.g. contracts and hierarchies). In such cases, mere economic incentives alone are deemed sufficient governance mechanisms within the relationship type.

Economic theories have long proposed market mechanisms as the theoretical explanation for successful economic outcomes in relationships of a transactional nature (e.g. Williamson, 1973; Penrose, 1959). However, the portrayal of the university and business relationship as merely a link to knowledge access or financial resources give little attention given to the various forms of commercial activities that a university might be engaged with and the dynamic governance issues that surround the alignment of such diverse partners in collaborative research projects. There are several different formats for transferring knowledge between a university and a business, which ranges from licencing university developed patents to co-developed knowledge. This assumption ignores that a network of relationships between and among businesses and universities can only generate *opportunities* to create value, but not the *realization* of value (Hughes, Ireland & Morgan, 2007; Hughes, et al., 2014).

An open innovation relationship between a university and business may require a much stronger relational linkage than that of a market-based mechanism, and is greatly impacted by the context and outcome expectations defined by the partners. The strategic complexity, alignment of knowledge motives and management practices (Houghton et al., 2009) has firms pursuing the assistance of intermediaries to assist with the challenges of connecting with partners (Hossain, 2012). The trends in the literature and in practice seem to overlook the potential for collaborative opportunities between a university and a business, and how this can be managed. The next section of the chapter will introduce theories of inter-organizational relationships and their implications for analysis and strategy.

2.4 Inter-Organizational Relationship and the University-Businesses Open Innovation Conundrum

Although it seems apparent that the primary objective of university and business partnerships is to generate innovations, the potential for differing objectives that each party may hold surrounding value realisation indicates a potential for conflict that hitherto lacks clarity. As was shown in the previous section of this chapter, there are significant incentives and pressures for this type of collaboration to form, with policy-makers developing initiatives and managers seeking to reap the benefits of efficient innovation. Despite the growing body of literature on technology transfer, there is evidence that the performance of these relationships has been falling short of meeting expectations.

Section 2.3.2 of the literature review illustrated that there are three different modes of open innovation, inbound, outbound, and coupled processes (Gassman, Enkel, & Chesbrough, 2010). The engagement with each of these processes depends on the knowledge resource deficiencies (or surplus) motives. Within this stream of literature, universities are frequently cited as a source for inbound innovation and indicates a prevailing assumption that the primary form engagement is in the form licensing or commissioned research for basic scientific exploration. However, evidence suggests that university technology transfer through the form of transferring intellectual property is under-performing. This thesis proposes that a coupled process of open innovation has greater potential to generating innovations, mutual benefit, and shared value, yet there are few reports on how this type of collaborative partnership might be enacted, developed, and maintained in a mutually beneficial way.

The research history on university-businesses as open innovation partners has yet to fully embrace the literature on inter-organizational relationships. It is proposed by bringing together the body of work of open innovation, university-business research collaborations, and inter-organizational relationships important new contributions to knowledge can be made to understand how the interaction of network structure, content and behaviour facilitates the co-development of knowledge, knowledge and resource flows, and open innovation. The forthcoming section aims to discuss several inter-organizational theories that are implicit in the university-business open innovation research; transaction cost economics, institutional theory, and resource dependency theory. As revealed in the previous section, there is a strong tendency within the literature, as well as within the policy statements and documents, to emphasize market based mechanisms as a sufficient form of governance (e.g., contracts and hierarchies),

such as that of transaction cost economics. University and business open innovation relationships generally have been portrayed within the literature as merely a link to access knowledge or financial resources, with little attention given to the complexities of the management issues

Public funding for research has decreased in availability, universities are becoming more dependent on private investment and focusing towards commercializing research. Businesses are disaggregating their R&D departments and are looking more efficient means to remain competitive in dynamic market, access knowledge stocks necessary for innovation development, and reduce expenses (e.g. Hutson & Sakkab, 2006). The businesses, in this form of relationship, might also become more dependent on university knowledge stocks. The literature review then introduces resource dependency theory as an alternative lens for analysis. These organizational theories provide an underlying basis for understanding overarching firm behaviour, in practice these relationships are held and enacted by human actors embedded in networks within a large-scale open innovation relationship. The purpose of this section is to reveal the implications of the researcher's implied theoretical position.

The final section aims to provide an overview of the various forms of inter-organizational relationships that hold relevance to university-business collaborations and aims to illustrate how these different business models vary in their degree of integration, format, and characteristics, and implies that the composition and management of network or collaborative partnerships between a university and a business is complex. The literature review conducted on open innovation and university-business collaborative revealed that the potential for a coupled process of knowledge generation and mutual benefit is under-appreciated, an understanding of both the macro-level and micro-level behavior of this form of inter-organizational relationship is essential to providing a complete view as to how this relational type might be analyzed and managed.

2.4.1 Overarching Inter-Organizational Theory Implied in University-Business

Literature

There are several inter-organizational theories implicit in much of the existing university-business open innovation research and policy. As mentioned previously, there is a strong tendency to emphasise the potential for organizations to pursue technology transfer and knowledge resources from a university, yet the literature in this area has largely overlooked the literature on inter-organizational relationships. There are many complex aspects of managing inter-organizational relationship, but the literature readily appreciates the possibility for resources to be transferred across organizational boundaries. This section discusses the supra-individual conceptions of organizational behaviour. By providing a brief discussion of transaction cost economics, institutional theory, and resource dependency theory, light can be made on the impact the theoretical positions of the literature, and, thus, the analysis and recommendations made for building business models and strategic approaches for management. The last section presents an overview of the different forms of inter-organizational relationships and links them with current university-business practice.

2.4.1.1 Transaction Cost Economics

The research on university-business relationships focuses merely on the transfer of knowledge between organizations through licencing or a consultancy project (Chesbrough, 2003, 2006; Melese et al., 2009) and overlooks the potential for co-developed innovations. Generally, firms participate in this form of partnership to gain access to upstream knowledge bases rather than technologically specific product knowledge (Feller, Ailes & Rossener, 2002). The implicit assumption lies within developing ties through contractual based arrangements (Chesbrough, 2003; Huizingh, 2011; Hossain, 2012; Ye & Knakanhalli, 2013) in which organization might commission or licence research. For instance, Chesbrough (2003) illustrates the potential for open innovation relationships, but only briefly mentions the need for developing a relationship through a variety of contract based relationships. This implies a theoretical assumption that market-based mechanisms serve as sufficient governance, whereas contractual arrangements have the potential to dictate performance and outcomes (Chesbrough, 2003). The relational ties between a university and a business might be expected to be characterised by fixed contracts and illustrate clear expectations in the contractual phases. However, this economic assumption neglects the social aspect of how opportunities for value creation between (and among) affiliated parties might be initiated, effectively developed,

maintained, and enacted to the extent that either party would acquire external knowledge or resources (relevant to innovation and value creation) in the absence of immediate returns.

Transaction cost economics (TCE) offers a basis by which to understand and explain the ways in which university developed innovation has either been organized within the firm or acquired from the market (Coase, 1937; Williamson, 1973). This theoretical framework has been utilized to explain the economic ‘price’ of firm behaviour, but is not limited to purchasing or selling in the traditional sense. It was constructed through the rationality of economics, contract law, and organizational theory to identify a governance mechanism that best meets the needs of individuals to organize and predict economic activity by firms (Williamson, 1973, 1978). This theory assumes that a firm possessing all the resources needed to innovate will do so internally, thereby holding the potential to maximize its rent appropriation (Hatch & Dyer, 2004). It also recognizes that variances in a firm’s resource endowments may motivate an innovation strategy and necessitate the requirement to develop external resources. The TCE acknowledges the value that can lie within long-term relationships and are capable to access external resources needed to maintain a competitive advantage.

The TCE generally foresees two organizing mechanisms: the ‘market’ and the ‘hierarchy’ (or firm). The markets are the starting point for relationship development, and implies that various forms of transaction cost and points of exchange exist along continuum to the point of hierarchal governance (Powell, 1990). This is because markets offer simplicity in the transaction process; whereas prices and fees dictate the exchange, communication is standard and simplified, and individual behaviour does not require overarching control (Powell, 1990). This is how the TCE deviates neo-classical economic theory, in the sense that it considers the ‘transaction costs’ of human and social behaviour as well as the limitation of contracts in forecasting all elements of exchange. It assumes that humans often seek out profit maximisation in a pursuit of self-interest, and discusses the impact of opportunism on relational exchange. It also assumes that humans are characterised by bounded rationality, through which decisions are often made based on availability heuristics and the associated ‘cost’ with processing the information (Williamson, 1973; Sirmon, 1991). As relationships gravitate towards inter-organizational networks, hierarchies and control mechanisms are the alternative to market mechanisms (Powell, 1990). The behavioural uncertainty and the unpredictability among potential partners negates the potential for contracts to be fully inclusive (Zaheer & Venkatraman, 1995). Stated differently, the focus of the TCE tends to be thought of as contractual arrangements as the basis for governance in inter-organizational relationships

whilst also acknowledges that human elements are essential to long-term strategic relationships (Williamson, 1973; 1978).

A significant issue with adopting TCE, as an approach to university-business relational governance lies, within the threats to the potential sustainability of a given relationship. Under the TCE, the extent to which a relationship is sustainable is determined by the amount of time that it takes to develop resources (e.g. for innovation) within the organization and to eventually achieve greater efficiency through economies of scale and capture more of the value available (Powell, 1990). The goal of the exchange will gravitate towards eventually reducing the cost of the transaction and profit maximisation, either through acquisition or contract completion. The TCE overlooks the potential for other forms of viable forms collaboration and exchange (Powell, 1990) in that economic transactions are determined by calculations of individual opportunism absent of social obligations (Granovetter, 1985). Under these assumptions, relationships may initially be characterised by market-based contracts, in which communication is guarded and goals are defined to serve the best interest of the actors.

Contract based relationships may not provide the access or knowledge sharing behaviour that is required to foster innovation capabilities between external entities as it only connects “two people only at the edge of their personalities” (Walter, 1983: 83; Powell, 1990). The transaction costs of accessing external knowledge sources may contradict the social elements of innovations process and has implications for the performance and outcomes of open innovation (Keupp & Gassmann, 2009; Huizingh, 2011) The involvement is normally limited with bureaucratic administration procedures that limit knowledge sharing and can result in the duplication of efforts, legal resolution for conflicts, and limits to the relationship.

There are risks of failure that emerge for relationships designed to follow strict contractual arrangements which are different from inter-firm relationships that develop informal governance mechanisms, as there is likely to be market exchanges instead of relational rents. This logic of hierarchal power and structures, that utilize rigid processes to specify partner responsibilities, contradicts the spontaneity and flexibility necessary for innovation to occur (Sivadas & Dwyer, 2000; Slater et al., 2014). Firms risk increase control and rigidity through subcontracting, as imbalances may begin to exist the asymmetric levels dependence and power are not in their favour (Dyer & Singh, 1998; Reid et al., 2001). External contributors that exercise power can derail internally developed technology trajectories, which may never materialize (Almirall & Casadesus-Masanell, 2010; Sisodiya et al. 2013). Managing for

innovation has a high level of uncertainty requires a deeper level of commitment from partners in the innovation process. In fact, research suggests the deeper integration and greater resource commitments, such as those of equity based joint ventures, are more effective at transferring of complex capabilities than are contract based alliances (Mowrey et al.; 1996). This thesis argues that these market-based assumptions overlook how opportunities for value creation between (and among) affiliated parties might be initiated, developed effectively, maintained, and enacted to the extent that either party would acquire external knowledge or resources (relevant to innovation) in the absence of immediate returns, as developing rigid business models have the potential to limit the act knowledge creation (Allen & Strathem, 2005).

2.4.1.2 Institutional Theory

The complexities of national policy, as well the requirements of the funding bodies and legal aspects of university-business relationships play a significant role in the direction of the research conducted in this area. As evidenced in the university-business section of the literature review (2.3.3), there are significant efforts and pressures from national governments on this formation of this form of relationship within the United Kingdom. Recessionary pressures and evidence of strained public resources has influenced the call from Government for greater university-business engagement across the nation and for shared resources in the pursuit of technology development. The Government hopes is to influence the innovation landscape for higher levels production and to stimulate growth economy by better utilize national resources (Salter & Martin, 2001; Metcalfe, 2010; BIS, 2012; Wilson Review, 2012). Yet, fundamental issues remain as evidence suggests that these collaborations are falling short of meeting expectations, regardless of the financial contributions made.

Institutional theory proposes that political and social norms (e.g. culture) serve as an authority to the behaviour and interactions (DiMaggio & Powell, 1983; Suchman, 1995). From a broad-level and political perspective, institutional theory proposes that state initiatives either impose constraints or facilitate collective action within supra-level social structures. It is typically utilized from the perspective of political science, but can also be used to understand the impact of external environments on the behaviour of firms operating within different nations (Scott, 1987; 2008). From this perspective, it assumes that institutional pressures a basis for authority and will result in conformity to legal, socio-cultural, and political norms as the individuals seek to gain legitimacy in their environment. However, the influence and durability

of policy measures directly impact the flow of resources within and between organizations (DiMaggio & Powell, 1983).

This approach is typically applied to macro-level environments and has been utilized to describe the sociological behaviour of organizational relationships. The underlying basis relies upon an assumption of cognitive and cultural conformism to not only the external environment but also to the more dominant organization (Scott, 2008). Member conform, through a process called isomorphism, to establish legitimacy to not only address the external environment and pressures, but also the normative behaviours and organizational cultures of the more powerful entity (entities) engaged within the relationship (DiMaggio & Powell, 1983). Bounded rationality and self-interest form the motives for establishing legitimacy. This view is typically applied to understand the overarching structure of social control, which often includes political activities within the nation of operation, through an understanding of culture and normative behaviours.

Institutional theory typically stands as a theoretical contrast to transaction cost economics, yet is complementary in our current understating of the university-business conundrum. From a macro-economic view, the policy statements issued thus far regarding the nature of university-business relationships makes similar implicit assumptions the transaction cost economics approach mentioned in section 2.4.1.1. The reports issued acknowledge the potential for universities to be an integral element of the supply chain (Wilson Report, 2012), in which alignment will present significant national efficiency benefits, however the guidance suggest that relationships are expected to develop through contractual and legal obligations. In some ways, the institutions that influence the development of this relationship type assumes markets and hierarchies as the basis for governance. As was discussed, the TCE presents limitations to developing an understanding of the socially complex elements of innovation emergence and how partners can be organized for high performance, and there is a risk that conformism to policy measures will result in a formalization the inhibit innovation outcomes. In fact, evidence from a recent report, which compared findings of 2008 study with 2011, reveal that the development of formalized processes (e.g. IP, procedures, and documentation) for open innovation strategies has increased in desirability (Chesbrough, 2013). However, the complexities of the funding structures and legal obligations support the tendency for research to focus on the impact of these institutional measures, and the hierarchal structures or markets may undermine the process of innovation. There are also risks if the process of isomorphism will occur within this form of relationship. As universities venture into the development of

commercializing research, there are ways to share potential practices and culture from the partnering organization, which present a mixture of implications to current practice. However, this increases in complexity if the university holds several relationships and must adjust practices with many external partners. Yet, there are alternative approaches to viewing this form of relational exchange that allow for collaborative work. The next section will present resource dependency theory as an alternative to current trends and assumptions made within the literature.

2.4.1.3 Resource Dependency Theory

Resource dependency theory offers an alternative theoretical perspective to university-business relationships. This theory places on emphasis on the interdependent nature of organizations with their external environment to acquire external resources and reduce uncertainty (Pfeffer & Salancik 1978; Barringer & Harrison, 2000). However, it is not limited to simply resource acquisition and deficiencies. It varies from the previously mentioned theoretical perspectives in that it views organizations as an ‘open’ aspect of society, within a network of inter-dependencies to other organizations and the external environment (Pfeffer & Salancik, 1978; Hillman et.al, 2009). The motives driving firm behaviour are situational (and potentially mutual) between partners, rather than predetermined as implied as in transaction cost economics or institutional theory.

Resource dependency theory proposes a level of partial isomorphism as collaborating firms increase their inter-dependence (Gulati, 1995). However, the organization that holds the resources, and which others are dependent, would be that which has power (Provan et al., 1980). Organizations may also rely on those that dependent on their resources (e.g. buyer-supplier relationships) insomuch that power is mutually exclusive and found embedded in the socially complex networks of relationships embedded within the inter-organizational relationship (Gulati, 1995). In terms of the university-business conundrum, this theoretical lens allows research and analysis to abstract away from the assumptions of power dynamics (either in the form of hierarchies or institutions) or market-mechanism as the primary governance mechanisms.

2.4.2 Forms of Inter-Organizational Relationships

There are several forms of inter-organizational relationships that can be pursued in the development of university-business research collaborations. Per Berringer and Harrison (2000), each form of inter-organizational varies in the degree of interaction and integration

between the partners. Figure 5 provides an over-view of the commonly studied inter-organizational forms, and links these forms to existing commercial activities pursued by universities.

Figure 5 - Linking inter-organizational forms to University-Business Activities

Inter-organizational Form	Degree of Interaction (Barringer & Harrison, 2000)	Description	University-Business Activities
Joint Venture	Tightly Coupled	Pooling resources to create a separate entity (Inkpen & Crossan, 1995)	Spin Outs and Incubators
Network	Tightly Coupled	Social connections in which partners focus on individual competencies (Bluedorn et al., 1994)	Large-Scale Collaboration
Consortia	Tightly Coupled	Specialized joint venture for R&D (Brooks, Blunden & Bidgood, 1993)	Research Centres and Consortiums
Alliance	Loosely Coupled	Exchange Relationships but no joint ownership (Dickson & Weaver, 1997)	Technology Parks
Trade Association	Loosely Coupled	Knowledge sharing in industries where lobbying activity (Gupta & Lad, 1983)	Conferences and Workshops
Inter-locking Directorate	Loosely Coupled	Sharing Directors among firms (Burt, 1982)	Scientific Advisory

As can be seen in the chart, there are several different opportunities in developing university-business partnerships, each with varying degrees' commitment and integration. It illustrates the complexities that universities must face in simultaneously managing these various forms of commercial activities in which they are engaged. Each of these forms of commercial activities require different managerial approaches, and represents a different stream of research within the inter-organizational literature. Yet, this is a under-appreciated area of the literature and practice.

This thesis focuses on the large-scale collaborations within the university-business context, adopted a network approach to understanding interactions and social processes of innovation emergence in a coupled open innovation model to allow for mutual benefit and co-

developed knowledge. Ultimately, the realisation of value depends on the extent to which the relationship(s) between a business (actor) and university (partner) creates and facilitates social (or relational) capital (Nahapiet & Ghoshal, 1998; Adler & Kwon, 2002; Inkpen & Tsang, 2005; Hughes & Perrons, 2011). A large body of literature that indicates that these relational capabilities positively affect the performance of innovative outcomes (see Kale, Singh, & Perlmutter, 2000; Mooi & Frambach, 2012; Sisodiya et al., 2013). As will be discussed in the next section, establishing a collaboration between a firm and a university reveal nothing about what outcomes are generated for what parties or how they are generated and the review will examine the micro-level interactions and network theory in greater detail.

2.4.3 Section Discussion

This section discussed the over-arching inter-organizational behaviour theories that are often implied (or assumed) within the university-business open innovation. It aimed to reveal the implications, risks, and limitations these theories pose for and within the context of this type of relational linkage. The review conducted in 2.3.3 (Universities as Open Innovation Partners) illustrates, much of the literature on this topic focuses the impact of formal governance (e.g. funding) mechanisms of partnerships and the explicit research performance or the impact of policy on the development of this form of relationship (e.g. patents). Whilst these are complexities that must be understood, it overlooks the micro-level and social aspects of managing this form of relational context for mutually beneficial outcomes and for innovation performance.

An implicit assumption of transaction cost economics might be suited as theoretical basis and business model for some forms inbound open innovation for firms to access knowledge resources from a university. For instance, licensing intellectual property and/or commissioning academic research for a better understanding of pure science might only require a contractual element and weak links between the organizations. However, it poses significant risks when applied to the context of a coupled open innovation process with universities, as it assumes that the relationship will either result in some form of internal integration to maximise rent appropriations or cease to exist once the organization has acquired all the resources to address their deficiencies.

Institutional theory might be appropriate in the analysis for some research into this form of relationship as well, but has limitations. Universities are public institutions, regulated, engaged, and financed by a wide range of political bodies and social groups. They o hold

significant societal responsibility to not only the national innovation landscape through commercially applicable research but also to contribute to the global discussions for improving the contemporary knowledge base. Whilst the research conducted in this area is significant and important, the true nature of the micro-level processes that occur within the knowledge exchange activities and relational context of this form of open innovation has been overlooked. Additionally, much of this work also makes assumptions that universities are a source of inbound open innovation and aligns with implicit assumptions made under the transaction cost economics approach.

This study aims to understand how co-developed knowledge stocks and mutual benefit can occur between a university and business in a coupled process of open innovation. It proposes that members of university and business relationships have the potential to operate as separate entities and a long-term basis through each alignment of resources and contributing their individual areas expertise without necessitating integration or point of redundancy. It employs resource dependency theory as the implicit basis for the investigation and aims to understand the roles of the partners within an open system.

The final portion of this section provided an overview of the different forms of inter-organizational relationships and attempts to align them with current forms of commercial engagements made by universities. Whilst it is beyond the remit of this thesis to discuss each aspect, and corresponding literature, it indicates that a wide range of inter-organizational activities already occur within the university-business landscape and presents an opportunity for future research. It illustrates the complexities that universities must face in simultaneously managing these various forms of commercial activities in which they are engaged, and illustrates that managerial approaches and anticipated outcomes represents a different stream of research within the inter-organizational literature. This adds another layer of complexity to the university-business coordination, as the funding mechanisms, legal aspects, and social pressures already impact this type of relationship in significant ways. The managerial complexities have remained an under-appreciated area of the literature and practice. The final section of the literature review presents social capital theory the theoretical basis for this thesis and will be discussed next.

2.5 University-Business Open Innovation Networks and Social Capital

To this point, the literature review has revealed significant complexities in the coordination, management, and effectiveness of university-business open innovation processes. Largely, the nature and direction of the literature conducted on university-business open innovation has focused on a single mode of knowledge transfer (e.g. licensing intellectual property and/or inbound open innovation) and obscures the potential to recognize the complexities associated with alternative means of commercial engagement (e.g. collaborations, spin-outs, and coupled processes of open innovation). Through aligning the commercial activities of universities with the well-established theories of inter-organizational relationships, there is greater potential to appreciate the complexities associated within this form of relational type.

This thesis proposes a coupled process of open innovation (Gassman, Enkel & Chesbrough, 2010) for university and business collaborations, insomuch that this form of relationship might result in mutual knowledge generation and benefits in the new product development process. It proposes that a university and a business can pool capital intensive resources (e.g. financial, human, social, or intellectual capital) to gain greater efficiency in the innovation process by drawing upon each of the partners' area of expertise, and through large scale collaborations and inter-organizational networks (Wilson Review, 2012). It posits that there are opportunities for firm-level expertise (e.g. markets, supply chain, scale of operation and exploitation therein) to enhance commercial activities conducted at universities, such as those benefits that are listed within the Wilson Review (2012) and United Kingdom's Strategy for Sustainable Growth (2011).

Universities possess superior capabilities in scientific exploration and can provide firms with access to innovative trends in research. Through effective alignment and management practice, this form of inter-organizational relationship can collaborate to achieve both the exploration and exploitation chain of learning and innovation (March, 1991). However, the literature review conducted on open innovation and university-business collaborative relationships revealed that the potential for a coupled process of knowledge generation and mutual benefit is under-appreciated. The complexities of this relational type are grossly understated in the managerial guidance and the policy documents issued thus far.

As illustrated in section 2.4.2, this form of collaboration is most closely aligned with a network form of inter-organizational relationships. This section will discuss the benefits and challenges that a network holds for partners and the literature in more detail. The route to generating novelty and innovation (whether in the exploitation or exploration part of the

process) is largely contingent on complex human and social elements that must be aligned and coordinated to access, release and generate knowledge necessary for novel outputs (March, 1991; Kogut & Zander, 1992; Nonaka, 1994; Rodan & Gullunic, 2004) and must be understood for enhancing performance. The purpose of this section is to discuss the complexities in developing, designing, and managing the micro-level processes in university-business relationships that focuses on co-developed knowledge stocks, and present the theoretical underpinnings of this research project.

This section begins by discussing the network approach to forming innovation-based inter-organizational relationships, whilst also utilizing the collaborative research projects built between universities and business as a context. The final section then introduces the theory of social capital as the theoretical explanation for mutually beneficial university-business research collaborations built for new product development. This theory proposes that goodwill facilitates and unlocks the potential for complex knowledge and other resources to be made available amongst a network of relationships. These relationships are characterised by cooperation and trust as people aim to benefit the greater good (or team objectives), which directly impacts their implicit 'value' for transacting the resources available and within the network. This section focuses on defining the various components of social capital (e.g. relational, structural, and content). It discusses themes and variations in the stream of literature regarding the development of social capital over time, the boundaries of social capital transmission, the potential for formal social capital structures to be strategically built for innovation performance, and the impact of informal social capital on performance

. This thesis argues that utilizing the social capital theoretical lens to understand the relational context of university-business relationships can enable scholars to understand how and why open innovation outcomes may emerge (or not)., and aims to provide an explanation to how relationships can be organised and managed to not merely generate social capital but also to use it to 'transact' and 'transfer' knowledge and other resources that may go into shaping valuable innovation outcomes.

2.5.1 University-Business Inter-Organizational Network

This thesis specifically examines the relational development and strategic implications of university-business coupled processes of open innovation through applying the concepts and theories of network inter-organizational relationships, as it aligns closely to the collaborative research format of commercial activities built within this relational type (in terms of overarching objectives, composition, and resource sharing practices). From an inter-organizational perspective, a network relational approach is that in which businesses (or universities) are positioned between and among a population of other organizations (or individuals) to share some form of resources or capabilities (Powell et al., 1996; Barringer & Harrison, 2000; Laursen & Salter, 2006) in response to some form of uncertainty or external pressure (Jones et al., 1997). Within an open system and macro-level view, there may be many organizations exhibiting some form of connection with many other organizations. The inter-relationship that universities (and indeed their partnering businesses) hold are likely to contribute (or impact) this type of collaboration, as well as the intra-relationship behaviors.

The benefit of engaging within a network form of inter-organizational relationship lies within the flexible ability for an organization to remain as a semi-autonomous node in their area of specialism (Bluedorn et al., 1994) whilst also accessing resources (Powell, 1990; Daata, 2011). Through a process of diffusion, firms can access or transmit ideas and other forms of knowledge within networks of relationships to be shared or accessed among the actors (Daata, 2011) to potentially learn faster (Dyer & Hatch, 2004b) and to promote innovation (Chang, Chung, & Mahmood, 2006; Mooi & Frambach, 2012). Through creating borderless organizations (Jarillo, 1993) and building inter-organizational cooperation (Kim et al., 2010), networks can be used as a means for strategy change (Dittrich & Duysters, 2007; Houghton, Smith, & Hood, 2009) or as a source of social capital to enhance innovation and learning capabilities (Koka & Prescott, 2002). However, network governance has been associated with various social mechanisms (Jones, Hesterly, & Borgatti, 1997) and is influenced by an array of contextual features.

There are many contextual and social psychological influences that impact the functioning of a network. For instance, alliance context is likely to make an impact and partner selection (Shah & Swaminath, 2008) as there may be difficulties in aligning cultures for open innovation (Herzog & Leker, 2010). Additionally, the role of power (Faria & Wesley, 2002) and the effects of group polarization phenomena (Myers & Lamm, 1976) presents challenges in ensuring that the environment is conducive to the conditions necessary for facilitating knowledge exchange and innovation emergence. There are also complexities associated with

influence of social capital on strategy choice and the challenge with managing the internal and external networks (Houghton, Smith, & Hood, 2009). These challenges are compounded with the issue of defining the appropriate methodology for organizational network studies (Schuller, 2000). This thesis proposes the theory of social capital as the theoretical explanation for mutually beneficial university-business research collaborations built for new product development, and aims to contribute to the literature on open innovation. The next section discusses social capital theory and network theory in depth.

2.5.2 Social Capital Theory

Contemporary business relationships are characterised by a new level of inter-organizational and multi-faceted cooperation that are dependent on mutual benefit, trust, interaction, and open communication channels aimed, and at sharing risk and resources in a way that extends beyond contracts (Powell, 1990; Zaheer et al., 1998). Social capital offers a theoretical lens to analyse and interpret the nature of social relations between organizations, and proposes that relational ties hold the potential to facilitate, mobilize, and unlocks the transfer of knowledge and other resources throughout a network of relationships (Adler & Kwon, 2002). These inter-organizational relationships are characterised by cooperation and trust as people aim to benefit the greater good (or team objectives), which directly impacts their implicit ‘value’ for transacting the resources available and within the network. It has been widely accepted as an informal governance mechanism that influences the opportunities that lie within relationships (Gulati et al., 2000; Hughes et al, 2007, 2014).

Several social science disciplines have employed the concept of social capital to explain value creation in relational contexts (Adler & Kwon, 2002). It has been accepted as an informal form of governance mechanism that influences the opportunities that lie within relationships, possessing the ability to facilitate the transfer of knowledge within a network (Gulati, Nohria, & Zaheer, 2000; Hughes et al., 2014). Indeed, sociological theory has long proposed that patterns in social connections are likely to influence a variety of phenomena. This logic is so prevalent within sociological theory that historical debates span back to the German sociological traditions of Simmel and Marx in the 1930s (Carrington & Scott, 2011). It has been utilized to discuss the benefit and fabric of the goodwill found within communities through the development of trust and reciprocity (Field, 2003).

Within the realms of organizational research, a body of literature supports that social capital does, indeed, accelerate the economic performance of firms (Granovetter, 1973; Uzzi,

1996, 1997). These economic benefits include improvements to economic efficacy through reducing administrative or transactional costs (Adler & Kwon, 2002; Lazerson, 1995) and enabling value creating knowledge sharing within and from relationships (Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998; Gulati et al., 2000, Hughes et al., 2007). It has been associated as the ‘essence of strategic leadership’ as managing social capital (Hitt & Ireland, 2002) as a strategic method for generating wealth. The benefits of social capital as a governance mechanism is that it enables firms to access intellectual capital (Nahapiet & Ghoshal, 1998; Hitt et al., 2002), enables knowledge transfer (Inkpen & Tsang, 2005), provide learning advantages (Hughes et al., 2014), aids entrepreneurial ventures (Stuart & Sorrenson, 2007; Kim & Aldrich, 2010), strategic alliances (Koka & Prescott, 2002), and facilitates collaborative innovation (Ketchen, Ireland, & Snow, 2007)

Social capital theory is a branch of network theory. The interactions, the relational linkages, the characteristics of the actors, and the resources that become available are typically studied from three different perspectives, content, structure, and behaviour (Ng & Feldman, 2010). This stream of research has an emphasis on the significance of generating relational ties to enable access to and the transfer of knowledge and resources (Gulati et al., 2000; Hughes et al., 2014). However, challenges remain in understanding how to these resources may go into shaping valuable innovation outcomes, that is relevant to both parties. There are is still a need for further conceptual development of the methodological approaches, as many research suggests the potential benefits vary across context (e.g. strategic and managerial approaches) (Gupta & Govindarajan, 1986).

2.5.2.1 Social Network Analysis

There is a deep inter-relationship between network theory, social capital theory, and the methodological approach of social network analysis. A social network analysis methodological approach can objectively display the contingencies of how the knowledge and knowledge resources flow between relational channels within networks that has both theoretical and practical implications (Wasserman and Faust, 1994; Prell, 2011). This study applies a social network analysis methodology and will discuss the approaches to research in more detail in the research design chapter of this thesis (chapter 3). However, understanding the alignment of this approach aids in conceptualizing this rest of this chapter and a brief overview is provided to enhance clarity if the discussion.

As mentioned previously, researchers often face difficulties in defining the boundaries appropriate for organizational network studies (Schuller, 2000). Additionally, this is made

more complex by variation in the research paradigms. Borgatti & Foster (2003) identifies two different streams within the network research (Please refer to the figure 6).

Figure 6- Typology of Social Network Research (Borgatti & Foster, 2003)

Typology of research on consequences of network factors		
	Social capital (performance variation)	Diffusion (social homogeneity)
Structuralist (topology)	Structural capital	Environmental shaping
Connectionist (flows)	Social access to resources	Contagion

This approach emphasizes the importance of identifying relational processes and the various components that influence not only collective action but also aids in predicting behavioural outcomes at the individual actor level to robustly define the phenomena of interest (Hanneman and Riddle, 2005). The relational linkages between actors serve as conduits for the resource flows (Granovetter, 1985; Burt, 1995). However, the prevalence of behavioural characteristics of the individual actors can be used to define compositional elements and helps to categorize specific clusters or cliques to describe variance within a dynamic network (Wasserman and Faust, 1994). This analysis seeks to identify and map the relational elements that enable (or constrain) the cross-functional resource flows that enable innovation and define the interactions between network structure, content, and behaviour.

This approach varies from the standard social science approaches in that it emphasises this interdependent nature of social actors (Freeman, 2004; Prell, 2011; Robins, 2012). The analysis focuses on interdependent observations which varies from the approaches that focus on the collection of a ‘sample’ of individual perceptions and standard predictive modelling. This research paradigm emphasizes the analysis of diversity among the network actors’ position and behaviour contributes to how they are embedded in specific networks and how the variance might present opportunities or constraints within their local interactions (Hanneman & Riddle, 2005; Scott, 2012). Whereas, the more prevalent method of social science analysis methods focus on the usefulness of attributes of autonomous individuals (Wasserman and Faust, 1994). These studies emphasize the importance of finding the overall effect of specific variables.

The theories and application of the social network analysis paradigm diverges from the overall objectives most commonly applied social science approaches. Social network analysis (SNA) deviates in regards to the emphasis on what and how the data might reveal phenomena of interest. “Instead of analysing individual behaviours, attitudes, or beliefs, social network

analysis focuses its attention on how these interactions constitute a framework or structure that can be studied and analysed” (Galaskiewicz & Wasserman, 1994). The actors and their actions embedded within the phenomena of interest are interdependent and are characterised by a variety of relational structures. The focus is on defining patterns of relationships and group dynamics rather than looking inwardly to the individual.

Social network analysis borrows concepts from graph theoretic notation and relational algebra, which is used to visually display network connections and to serve as information maps in identifying the significant features of a social structure (Borgatti et al., 2013). This approach adopts specialized terminology and concepts from graph theoretic notation and allows the researcher to approach objectivity through focusing on understanding and presenting the social facts (e.g. relational links), and measuring the intensity and influence of the various social constructs (Cross & Parker, 2004; Hanneman & Riddle, 2005). The analysis aims to explicate social relations that may emerge from a qualitative investigation in a way that is consistent with the scientific methods employed within the natural sciences (Kuhn, 1964) as well as acknowledging that the network includes local conditions (Wasserman & Faust, 1994). The primary objective of this stance is to reliably present consistent and approach objectivity information with regards researched to the measurement of properties and descriptions of the relational patterns (Hanneman & Riddle, 2005).

This section focuses on defining the various components of social capital (e.g. relational, structural, and content). the variations in the stream of literature regarding the development of social capital over time, the boundaries of social capital transmission, the potential for formal social capital structures to be strategically built for innovation performance, and the impact of informal social capital on performance. This thesis argues that the application of social capital can enable scholars to understand how and why innovation outcomes may emerge (or not) in a wide range of networks.

2.5.2.2 An Emphasis on Nodes and Ties

Social network analysis (network theory) focuses on the interdependent nature of actors (nodes) and the relational linkages (ties) to determine the flow of resources (e.g. social capital and knowledge) within a network of relationship (Wasserman & Faust, 1994). The focus of the research is on effect of inter-organizational and inter-personal networks (Sedita, 2008) and the act of resource diffusion through the relational links to node (Robertson, Casali, & Jacobson, 2012; Pentland, 2014), The general objective is to understand the various influences on the

motivation to share knowledge within a network (Chang & Chuang, 2011) and the impact on not only collective performance but also individual behavioral performance.

There is a large body of work that has focused on the function of specific nodes within the network. However, there is a lack of consensus of their role and the implications of their influence across the varying theoretical debates. For instance, there is often an emphasis on the role of network promoters in open innovation (Fitcher, 2009) as well as the importance of internal knowledge brokers (Cillo, 2005). But, there are also theoretical tensions in the network literature regarding the usefulness of structural holes (Burt, 1992) and strength of weak ties for innovation performance in collaborative networks (Granovetter, 1973; Ahuja, 2000). These authors argue that a network characterized by high levels of density will result in knowledge redundancy and that weak links provide novel information (Marriotti & Delbridge, 2012). The counter argument for high levels of embeddedness and strong ties (Uzzi, 1996; 1997) contribute to the acquisition of competitive capabilities and the complex knowledge transfer necessary for innovation performance (McEvily & Marcus, 2005). Recent research also reflects that the strength of ties oscillates (Hughes & Perrons, 2011). This leaves fundamental questions remaining regarding the degree of integration actors must possess to be effective. This indicates that relational context is likely to play a considerable role in the development of social capital, and may only be specific to local conditions.

There is considerable evidence that an actors network position often determines the level of influence that actor has upon the network (Schepis, Purchase, & Ellis, 2014). However, the counter arguments emphasize the importance of the whole network matters for governance and learning (Makadok, 2003) stating that the levels of knowledge heterogeneity influences performance (Rodan & Gallunic, 2004) and competitive capabilities (McEvily & Zaheer, 1999). There is also considerable evidence that the relational component of trust takes time to develop and plays a role in influencing strategy change (Dittrich & Duysters, 2007; Huemer, 2014).

2.5.2.3 Trust and Relational Behaviour

The levels of uncertainty avoidance and protection of proprietary information in inter-firm collaboration has the potential to inhibit innovation performance, which emphasizes the need for the development of trust and relational capabilities (Kale, Singh, & Perlmutter, 2000; Barr & Glynn, 2004) in a manner that allows for knowledge sharing (Kline, 2003) to facilitate innovation processes. Most studies employing social capital theory acknowledge trust and

reciprocity within interactions to be crucial relational components in the generation of social capital. By working together, actions driven by common (instead of competitive) interests can serve to improve conditions across several stakeholders involved in the relationship (Hughes & Perrons, 2011), but the organisation must then generate trust within the set of relationships it holds with another actor or set of actors for this to occur. This emphasizes the role of relationships and trust as a governance mechanism that improves performance (Zaheer & Venkatraman, 1995; Zaheer et al., 1998). However, there are challenges in conceptualizing the role of trust in business relationships as it extended by individuals' operations within the organization rather than the organizations themselves (Zaheer et al., 1998) and differentiating the dimensions and levels of trust, differentiating between individual and organizational levels holds implication for the transmission of ideas and knowledge flows (Ganseen & Hess, 1997).

Gulati (1995) distinguished between two types of trust, knowledge-based and deterrence-based trust. Knowledge-based trust is defined as the trust between two or more actors that emerges as they interact with each other, learn about each other, and develops norms of collaboration. Deterrence-based trust emerges from the knowledge that a partner will not behave opportunistically because of known costly sanctions that will follow. Deterrence-based trust is largely contractual in nature or at the least based on a very clear set of guidelines about penalties for malfeasant behaviour (Gulati, 1995). Knowledge-based trust, however, is based on social norms and is crucial when behaviours, events and outcomes cannot be fully contracted for. Concerns regarding the dark side of social capital and those that might take advantage of trust (Villena, Revilla, & Choi, 2011) through behaving opportunistically (Williamson, 1973). There is evidence of the negative effects when network hubs and brokers lie and distort information (Schilling & Fang, 2014). Mechanical trust and the necessity for some form of staging process (Dodgson, Gann, & Salter, 2006). However, there is evidence that rigid processes contradict performance in open innovation (e.g. Reingold, 2013).

There is an over-reliance on deterrence (mechanical) based trust mechanisms in the university-business literature. For instance, institutional pressures and the requirements of the BIS and the triple helix, the impact on the academic motivation has been of primary concern of the researchers working in this area (e.g. Benner & Sandstrom, 2000; Etzkowitz & Leydesdorff, 2000), and is influenced and implemented largely to deter opportunistic behavior. Yet, the formal structures and institutionalized organizations (Meyer & Rowan, 1977) form models that have the potential to limit knowledge creation (Allen & Strathem, 2005; Kadushin, 2012) and the ineffectiveness of economic for providing explanations for behavior (Larson,

1992). Additionally, the literature in this area emphasizes inbound open innovation as the mode of knowledge acquisition for this literature type (Gassman, Enkel, & Chesbrough, 2010), and does not accurately portray the potential for relational models and coupled process.

Given Zaheer et al.'s (1998) observation about trust and the execution of relationships taking place at the individual as opposed to firm level, knowledge-based trust takes precedent in the successful and effective management of relationships. Gulati's (1995) main argument was that trust and norms are a more effective governance mechanism than contracts. It can be argued that it is in fact network behavior that leads a firm to maintain unique and idiosyncratic patterns of network linkages and the consequential differential exposure to knowledge and ideas. Despite an implicit acceptance among existing studies that the social capital needed to unlock learning is behaviorally driven, there is a general absence of understanding into how firms go about the process of creating meaningful and trustworthy ties that build and bear social capital, or what effects such social capital development behaviors have on value creation thereafter (Granovetter, 1985; Ng & Feldman, 2010). Thus, it is necessary to consider the behavioral mechanisms through which relationships emerge and value is created (Stuart & Sorenson, 2007). The make-up of these behaviors has received little research in comparison to network structure and content, and therefore we know little about the forms such behavior should take.

2.5.2.4 Network Development Behaviors

The behaviour and act of knowledge sharing has been associated with many social psychological factors, organizational climates, and various external factors that often change (Bluedorn et al., 1994). Relational development behaviour has been strongly associated with providing an environment conducive to knowledge exchange (Carmeli & Azeroual, 2009). Through the development of cooperation, advantage and trust can be built over time (Huemer, 2014). Networks are not static, and the oscillation of new members and internal/external pressures influence the resources available and the knowledge creation therein (Nonanka, 1994; Hughes & Perrons, 2011). As well, as the impact of embeddedness and the effects of social capital development over time (Ng & Feldman, 2010).

Recent studies have called for a focus on relational behaviour (Hughes et al, 2014) and social capital development behaviours (Ng & Feldman, 2010). Studies into network development have focused on survival functions, network membership and the impact of network structure following significant events (Carroll & Hannan, 2000). However, there is a

need to review relational context, as it plays a significant role to the functioning and responses to environmental changes that occur over time. Despite an implicit acceptance among existing studies that the social capital needed to unlock learning is behaviorally driven, there is a general absence of understanding into how firms go about the process of creating meaningful and trustworthy ties that build and bear social capital, or what effects such social capital development behaviors have on value creation thereafter (Granovetter, 1985; Ng & Feldman, 2010). Thus, it is necessary to consider the behavioral mechanisms through which relationships emerge and value is created (Stuart & Sorenson, 2007). The make-up of these behaviors has received little research in comparison to network structure and content, and therefore we know little about the forms such behavior should take.

The relational and contextual features that impact and govern the evolution of the network development. Cross & Parker (2004) identified the first three phases of (organizational) network structure within an organic team. However, this adaptation of their theory and extension reveals additional contingencies and evidence that there have been four key phases to the development and coordination efforts. This approach is like an organizational life cycle (Mintzberg, 1984), in which growth and transitions from each phase of development are characterised by tipping points that stimulate dynamic change and focus within the social context of the organization (Gladwell, 2002). Each stage of network development is characterised by a point of revolution that shifts the relational development to a new phase of development (Greiner, 1972). By reviewing the key tipping points and actions taken in response, light can be given to the multifaceted processes that aided the development of this relationship.

To the researcher's knowledge there has not been an ethnographic study on the relational development of an open innovation network built between a university and business. Therefore, **Chapter 4** addressed the calls made to understand more about the development of social capital overtime. This chapter also aimed to understand the variation in the relational ties that influences the network activity and how they might contribute to value creation and innovation. This chapter reveals rich contextual factors and subjective inferences regarding the overarching structural and content related characteristics of the network structure (Ng and Feldman, 1999) by utilizing multiple methods of collecting qualitative data. Additionally, this analysis exercise focused on understanding how the relationship formed along with scooping for other participants and other probable sources of evidence (Carrington and Scott, 2012).

The extent to which value can be created from the opportunities presented within the network content and structure can only be realised through the behaviour the individuals acting within the social system. It aims to provide a temporal perspective of relational context and changes over time. The research investigation utilized Cross & Parker's (2004) stages of network development framework as the underlying basis for the investigation, and offers an extension to their model. The aim is to understand the dynamic nature of network development, and the various relational themes that emerge.

The following are the research questions that guided the study in chapter 4:

1. How does a university-business coupled (open innovation) relationship evolve over time?
3. How can a university-business coupled (open innovation) relationship be organized in terms of structure and content?
4. What are the prevalent themes of communications between university-business coupled (open innovation) partners?
5. What are the roles of actors in the university-business coupled (open innovation) relationship?
6. How do university-business coupled (open innovation) partnerships react to change?

2.5.2.5 Structure and Content

While research acknowledges the importance of relational components of social capital, such as trust and reciprocity, the focus in organizational research has primarily been on the structural attributes and process through which value can be created (Koka & Prescott, 2002; Larson, 1992) and variance in tie strength and quality among actors shaping the scope of value creation (Burt, 1992; Uzzi, 1996, 1997; McEvily & Zaheer, 1999; Reagans and McEvily, 2003; McEvily & Marcus, 2003;). Some researchers argue that network structure is of primary concern, as it predicts similarities between attitudes and behaviours (Burt, 1992). The network structure has been analysed from the perspective of tie strength (Granovetter, 1973), embeddedness (Uzzi, 1996), centrality, structural holes, and bridging into new networks (Burt, 1992). However, the body of literature on how the patterns of connections can be interpreted to generalize for social capital realisation is fraught with difficulties.

The value of knowledge transfer, information benefits, and the emergence of novelty (innovation) that arise from tie strength varies across perspectives. There is a body of literature that argues that weak ties among actors provide access to more novel and non-redundant information (Granovetter, 1973; Burt, 1992) and is, thus, a more effective means for generating the structural dimension of social capital. This argument states that the embedded (or strong ties) will reduce the possibility for diversity in knowledge and, thus, impact the levels novel information to emerge. Strong ties will result in knowledge redundancy over time through providing access to social structures with alternative information flows.

Other streams of literature contend that complex knowledge transfer is associated with strong ties (McEvily & Zaheer, 1999; Uzzi, 1996). Sorrenson et al. (2006) presents an argument that ties need to be strong to foster higher quality knowledge exchange with fewer transmission errors and that has the depth and richness needed to stimulate innovation rewards. Uzzi (1996, 1997) acknowledges the need to foster exchange through developing strong ties but illustrates the risks of lock in that results from over-embeddedness. Hughes and Perrons (2011) offered evidence to suggest that social capital is not built in linear fashion as ties evolve over time, and demonstrated that ties oscillate in strength over time. The ties have the potential for becoming valuable and requiring investment of time and interaction as their potential for value and rewards become more apparent (Hughes & Perrons, 2011). This indicates that while nature of a firm's ties and position in a network provide differential access to knowledge, conducting a structural analysis in isolation of other elements provides an incomplete assessment.

Studies have also sought to identify network type and complexity of the content being diffused (Rodan & Gallunic, 2004; Inkpen & Tsang, 2005). The content of the network can provide important determinants to understanding the value created by relational activities. Podolny (2001) defines the content attribute to as the individual characteristics of nodes. Rodan and Galunic (2004) proposed that a relationally-embedded approach would provide insight to the social capital creation given the inconsistencies of knowledge heterogeneity within network ties. McEvily and Zaheer (1999) contends that the unique patterns of network linkages expose actors to idiosyncratic pockets of knowledge. Researchers of network structure propose that exposure to a sufficient breadth of linkage types provides optimal results in networking activities but, network content scholars claim that the value of the structure itself is dependent on its content, composition, and attributes. Irrespective of structure and content, however, it is argued that ultimately networks only provide opportunities for value creation through the transfer of knowledge and resources (Hughes et al., 2007). Theoretically, knowledge transfer

can be enabled by social capital (Inkpen & Tsang, 2005) but it is the form of social capital that is important to consider. The process of unlocking access to knowledge and resources and enabling their transfer in value creating ways depends on the network behavior of actors and so represents a behavioral form of social capital (Hughes et al., 2014; Ng & Feldman, 2010). How a firm (or individual) accesses or develops the resources might only be relational specific and determined only by local conditions. In other words, opportunities for value creation must be enacted by individuals whose behaviour elicits trust, reciprocity, and the will to make available and transfer the knowledge and resources necessary for value creation (Hughes et al., 2014).

A network approach to understanding the performance and management of inter-organizational relationships varies in terms of the objectives of the researcher. In contrast to an open system network study, which might reveal dichotomous ties between many entities, some researchers focus on revealing the relational depth and context between two partnering organizations (Prell, 2011). The variations between the macro-level and micro-level views presents conceptual issues in the analysis as it makes it difficult to identify the boundaries of the network and all the potential resources that may become available, especially in the instance of an open system (Laumann et al., 1983; Wasserman & Faust, 1994). The micro-level approaches to analysis limit the boundaries to individual level and the types of relations impacting them from an ego-centric approach (Kilduff & Tsai, 2003). However, the units of measurements (Sedita, 2008) utilized in studies often have significant variations. This is made more complex as research suggests significant variations across organizational settings (Ahuja, 2000; Provan et al., 2007) which make them more difficult to manage and coordinate (Doz & Hamel, 1998). This study focuses on providing an in-depth relational context of university-business collaborations for knowledge generation and mutual benefit. Therefore, the analysis in **Chapter 5** of this thesis reviews the various ways in which a university-business network can be analyzed and the impact that various network structures have on the management and coordination of the innovation process.

Chapter 5 aims to the reveal the variations in the boundaries and approaches in analyzing a university-business network. It aims to reveal the extent of the potential resources that may become available in the open system (Laumann et al., 1983; Wasserman & Faust, 1994). This approach is compared with an overview of the micro-level networks designed for knowledge exchange. This chapter aims to reveal that alternative approaches to analysis, such as limiting the boundaries to an individual level (Sedita, 2008), defining the types of relations (Kilduff & Tsai, 2003) and the units of measurements (Sedita, 2008) for network study might

have various impacts on how the development of innovations within this form of relationship might be interpreted. There are significant variations across organizational settings (Ahuja, 2000; Provan et al., 2007) which make them more difficult to manage and coordinate (Doz & Hamel, 1998) and considerable external pressures and impacts that a university-business faces and is likely to impact the route to value creation.

The following are the research questions that guided the study in chapter 5:

1. To what extent is the university-business coupled (open innovation) partnership influenced by external actors?
2. What are the roles of the external influences that directly impact the focal university-business coupled (open innovation) partnership?
3. To what extent and in what context does the focal university-business coupled (open innovation) engage with external networks?

Little is known about the internal structure of a collaborative university-business open innovation relationship. **Chapter 6** investigates the formal structures are defined as obligatory task interdependence as stipulated by the projects and contracts, as a means of deterrence-based trust and strategic efforts to define knowledge heterogeneity. The over-arching coordination mechanisms and governance are complex aspects of the university-business partnerships and developing strategies for alignment is fraught with complexities. The role that technology transfer offices provide offer significant support ranging from the necessity to respond to a wide variety of institutional pressures to resource opportunity identification and governance philosophies. The focus on the appropriate approaches and responses to external pressures are essential to the effective functioning of the network, however the activities conducted within that level could be viewed as support mechanisms for ensuring the functionality and performance within the micro-level (scientific) network.

This network consists of human actors, who must develop the inter-personal capabilities to communicate and share knowledge with others (Huber, 1991; Wasserman & Faust, 1994; Clegg & Palmer, 1996; Hatch and Dyer, 2004). It is within this level that value creation emerges and knowledge creating benefits emerge (Newman et al., 2002). The organizational climate within this network must also possess the relational capabilities (e.g. trust and interaction) necessary for foster the knowledge exchange for innovation (Myer & Goes, 1988; Bock et al., 1994; Kale, Singh, & Perlmutter, 2000) and enable the heterogeneous

knowledge to flow within the network (Knott, 2003). This knowledge sharing activity between actors provides opportunities for mutual learning and inter-firm cooperation that stimulate the creation of new knowledge and, at the same time, contribute to the firms' collective and individual abilities to innovate (e.g., Kogut & Zander, 1992; Tsai & Goshal, 1998; Tsai, 2001) and relies upon relational capabilities (Carmeli & Azerouli, 2009) as well as the appropriate responses to various external factors.

The university-business open innovation literature identifies universities as a vehicle for inbound open innovation for firms, and focuses on the transfer of knowledge between organizations through licencing or a consultancy project (Chesbrough, 2003; Melese et al., 2009), which has the potential to overlooks the social complexities of the process in which co-developed innovations emerge. The underlying assumption that this type of relationship link is of a transactional nature guided by formal mechanisms (Bruneel, D'Este, & Salter, 2010). Therefore, an analysis of the formal coordination mechanisms (e.g. the contracts), utilizing a network approach, and a qualitative investigation of the informal networks will aid in understanding the coalescence between these functions to facilitate the collaboration and will help to define how network sustainability and innovation performance is achieved on the micro-level interactions. This thesis address calls by Kadushin (2011) for research to illustrate the difference between formal and informal social capital structures.

The following are the research questions that guided the study in chapter 7:

1. Can university-business coupled (open innovation) partnerships utilize formal (social capital) coordination mechanisms? (e.g. hierarchies or contracts)
2. To what extent does formal (social capital) networks contribute to innovation in university-business coupled (open innovation) partnerships?

This chapter also considers the impact of informal (social capital) elements. Informal informal structures were developed in term of relational elements, such as friendships, advice, and expertise. Additional, the informal chapter presents how members of university-businesses define value.

The following are the research questions that guided the study the informal section of this study:

1. To what extent does informal networks explain network cohesion in university-business coupled (open innovation) partnerships?

2. Do network actors utilise informal networks, not defined by their contracts, in university-business coupled (open innovation) partnerships? And, in what context?
3. In what ways do network actors acquire and define value creation in university-business coupled (open innovation) partnerships?

Finally, there are very few studies that aim to align and derive the contextual elements of a whole network within one study, insomuch that it identifies structural, content, and behavioural features that contribute to value creation. The following four research questions guided the overarching objective of this research investigation. The response to these four question will be reviewed in unison with the examinations provided in Chapters 4, 5, & 6. In Chapter 7, I will provide a discussion for each question through utilizing findings from all three of the studies included in this thesis.

1. To what extent do theories of network (social capital) structure, content, and behaviour individually and in unison explain value creation within university–business relationships?
 - a. (P1A) The structure of the network (social capital) will reveal value creating aspects of a university-business network.
 - b. (P1B) The content of the relational linkages found within the university-business relationship will impact value creation.
 - c. (P1C) The behaviour of the individuals embedded within the network will impact value creation.
 - d. (P1D) The behaviour of the individuals embedded within the network and their content specific capabilities will impact their position in the network structure in university-business relationships.
2. Given the complex interactions in network (social capital) structure, content, and behaviour, can firms coordinate and manage networks to derive innovation rewards?
 - a. (P2A) Complex interactions can be coordinated for innovation rewards.
 - b. (P2B) Complex interactions can be managed for innovation rewards.
3. In what way might network (social capital) structure, content, and behaviour interact to form a richer understanding of university–business relationships?

- a. (P3A) Network (social capital) structure and content interact to create value in university-business relationships.
 - b. (P3B) Network (social capital) structure and behaviour interact to create value in university-business relationships.
 - c. (P3C) Network (social capital) content and behaviour interact to create value in university-business relationships.
 - d. (P3D) Network (social capital) structure, content, and behaviour interact to create value in university-business relationships.
4. What features of a network (social capital) relationship can then be replicated and transferred to establish new value creating relationships and what might be local or specific to a relationship?
- a. (P4A) All aspects of university-business relationships can be replicated and transferred to establish new value creating relationships.
 - b. (P4B) All aspects of university-business relationships are localised or specific to a relationship.

2.5.3 Section Discussion

This thesis proposes that a university and a business can pool capital intensive resources (e.g. financial, human, social, or intellectual capital) to gain greater efficiency in the innovation process by drawing upon each of the partners' area of expertise through large scale collaborations (inter-organizational networks). For instance, a corporation might possess intimate market knowledge that aids in the exploitation process of new technologies while a university possess superior capabilities in the exploration process (March, 1991). However, the route to generating novelty and innovation is fraught with difficulties (whether in the exploitation or exploration part of the process) as it is largely contingent on complex human and social elements that must be aligned and coordinated to access, release and generate knowledge necessary for novel outputs (Nonaka, 1994; Kogut & Zander, 1992; Rodan & Gullunic, 2004).

This research project focuses on the management and coordination of university-businesses engaged in the coupled process of open innovation networks, insomuch that mutual

beneficial learning and knowledge generation outcome are main objectives. This type of relationship is fraught with complexities that are overlooked in the body of work that identifies universities as potential open innovation partners. For instance, the route to generating innovation and novelty has been strongly associated with the capability to transfer tacit knowledge across organizational boundaries, and it is well-established that transferring tacit knowledge requires relational and behavioural commitment. This thesis proposes that social capital serves as a vehicle for this form of knowledge exchange.

Generally, the components of social capital include relational, content and structural elements. The relational component is contingent upon the development of inter-organizational and inter-personal trust mechanisms. This is achieved through the development of deterrence-based and knowledge-based trust, indicating a variation between formal and informal mechanisms to govern behaviours. The content specific component speaks of the differential resources that actors may bring or make available to their network of relations. It provides the contextual elements of the relationship. Finally, the structural component is contingent upon various aspects of network design. For instance, the network size and the position that influential actors have, the influence of external networks, the degrees of interaction and evidence of reciprocation, and the cohesiveness of the overarching activities.

Whilst each of the streams of social capital have been researched within their own vein, this thesis proposes that to understand each of these components impact and implicit value on the development of social capital all three must be considering in unison to enhance the understanding over-arching relational context. This thesis utilizes the learning from social network analysis to the context of resources and the various impacts on the sustainability of the network.

2.5 Chapter Conclusion

This chapter provided an evaluative review of the topics and research surrounding the literature on open innovation, university-business relationships, and social capital/network theory, thereby situating the research objectives. The chapter began by stating the importance of planning of innovation activity for firms. It placed an emphasis on the resource intensive nature of generating knowledge stocks for innovation activities and the necessity to identify new capabilities for external knowledge acquisition and integration and, thus, aims to illustrate concerns regarding the application of traditional management concepts in explaining or forecast open innovation rewards and the generation of new knowledge. By discussing the

Resource Based View, the discussion reflects that most widely adopted and traditional logic that implied in research and business practices could inhibit the effectiveness and development of open innovation strategies for firms in several contexts (yet it emphasises the university partner selection for the focal discussion). The permeability of knowledge resources and the extent to which demands change impact the capabilities to pursue and develop the competitive assets that can produce regular streams of incremental or radical innovation outcomes. The traditional logic of inimitability and protecting core assets are less likely in rapidly changing markets, and this is why it is necessary for the literature to transition to a knowledge-based view.

The review then examines the body of literature on open innovation, specifically that which identifies universities as a potential partner. It begins by outlining the definition and context for open innovation activities, and the impact of strategy decisions are made in the transition from the traditional ‘closed’ innovation strategies to open innovation activities. It then discusses the impact of knowledge acquisition motives and the various modes of open innovation business models, which impact the partner selection process and the management of the resources from the outset. Interestingly, the open innovation literature frequently identifies universities as source of inbound knowledge flows, however the complexity of this partner selection remains under-examined. There are three different modes of open innovation, inbound, outbound, and coupled processes (Gassman, Enkel, & Chesbrough, 2011). The engagement with each of these processes depends on the knowledge resource deficiencies (or surplus) motives. Within this stream of literature, universities are frequently cited as a source for inbound innovation and indicates a prevailing assumption that the primary form engagement is in the form licensing or commissioned research for basic scientific exploration. However, evidence suggests that university technology transfer through the form of transferring intellectual property is under-performing. This thesis proposes that a coupled process of open innovation has greater potential to generating innovations, mutual benefit, and shared value.

The chapter then reviewed the current body of research that surrounds University-Business relationships, and begins by discussing the prevalence and importance of understanding this relational context. The recessionary pressures around the globe have impacted many facets of economic systems, and the role of academic research and teaching is critical to a nation’s innovation systems. The role that academia plays in economic prosperity is a subject of intense debates, and is the focus of many recent political agendas. There is a

growing expectation that universities must become more involved in developing efficiencies and sharing knowledge assets to stimulate the economy. This has resulted in decrease access to public funds, as governments are encouraging private sector funding and more academic research collaboration. As such, they have become more financially constrained as budget cuts are depleting research income. This commercial application of academic research to the private sector has significant potential to create shared value within a university and business collaborative partnership, however there are significant organizational differences that have the potential to impact value creation. However, much of the research conducted in this area focuses on the complexities of negotiating intellectual property ownership and/or funding mechanisms or the impact of policy on the patent performance. Whilst these are formal mechanisms for assessing innovation performance are frequently utilized to assess innovation performance, an over focus on these outcomes overlook the micro-level and social aspects of managing this form of relational for mutually beneficial outcomes and for innovation performance.

There is a common assumption within the university-business literature, in that it is generally depicted as merely a link to knowledge access or financial resources and has little attention given to the dynamic governance issues that surround the alignment of such diverse partners. Perhaps, one of the greatest gaps in the open innovation literature that identifies universities as a potential partner lies within the prevalent assumption that merely establishing a network will generate value and, therefore, the lack of examinations into how relational elements might function to continually achieve value creation for each partner. The trends in the literature also seem to overlook the potential for collaborative opportunities between a university and a business, and how this can be managed.

The section that followed suggests that greater insight can be derived by assessing the university-business relationships using the theories of inter-organizational relationships as a theoretical lens. These organizational theories provide an underlying basis for understanding overarching firm behaviour, and often the implicit assumption impact the nature of the research undertaken. The purpose of this section is to provide an overview of the often-implied assumptions found within the university-business literature, and was constructed to enhance clarity in the current debates.

The traditional assumptions of transaction cost economics have been implied in much of the existing literature and how this may impact the management and coordination of open

innovation activities with universities. It has been well established in the literature that innovation is dependent upon the communication that occurs between the people within the organization. Focusing too heavily on contracts or hierarchical structures is merely a supporting practice to the early stages of relational development. This theoretical basis might inhibit the understanding of how these relationships might function in practice and the current limitations of this approach. For instance, licensing intellectual property and/or commissioning academic research for a better understanding of pure science. However, it poses significant risks when applied to the context of a coupled open innovation process with universities, as it assumes that the relationship will either result in some form of internal integration to maximise rent appropriations or cease to exist once the organization has acquired all the resources to address their deficiencies.

Institutional theory might be appropriate in the analysis of some contexts of knowledge transfer within this form of relationship. Universities are public institutions, regulated, engaged, and financed by a wide range of political bodies and social groups. They hold significant societal responsibility to not only the national innovation landscape through commercially applicable research they must also contribute to the global discussions for improving the contemporary knowledge base. While the research conducted in this area is significant and important, the true nature of the micro-level processes that occur within the knowledge exchange activities and relational context of this form of open innovation has been overlooked. Additionally, much of this work also makes assumptions that universities are a source of inbound open innovation and aligns with implicit assumptions made under the transaction cost economics approach.

However, there is also a need to acknowledge a level of stand-alone influence, collaborative capabilities, and resource dependency between a university-business. Public funding for research has decreased in availability, universities are becoming more dependent on private investment and focusing towards commercializing research. Businesses are disaggregating their R&D departments and are looking more efficient means to remain competitive in dynamic market, access knowledge stocks necessary for innovation development, and reduce expenses (e.g. Hutson & Sakkab, 2006). The businesses, in this form of relationship, might also become more dependent on university knowledge stocks. The purpose of this section is to reveal the implications of the researcher's implied theoretical position.

This study aims to understand how co-developed knowledge stocks and mutual benefit can occur between a university and business in a coupled process of open innovation. It proposes that members of university and business relationships have the potential to operate as separate entities and a long-term basis through each alignment of resources and contributing their individual areas expertise without necessitating integration or point of redundancy. It employs resource dependency theory as the implicit basis for the investigation and aims to understand the roles of the partners within an open system. The section provided an overview of the different forms of inter-organizational relationships and attempts to align them with current forms of commercial engagements made by universities. While it is beyond the remit of this thesis to discuss each aspect, and corresponding literature, it indicates that a wide range of inter-organizational activities already occur within the university-business landscape and presents an opportunity for future research. It illustrates the complexities that universities must face in simultaneously managing these various forms of commercial activities in which they are engaged, and illustrates that managerial approaches and anticipated outcomes represents a different stream of research within the inter-organizational literature. This adds another layer of complexity to the university-business coordination, as the funding mechanisms, legal aspects, and social pressures already impact this type of relationship in significant ways. Yet, the managerial complexities have remained an under-appreciated area of the literature and practice.

The final section of this chapter presents the theoretical basis for this study, network theory and social capital. These theories have a deep inter-relationship. Social capital is generally “understood as the goodwill that is engendered by the fabric of social relations and that can be mobilized to facilitate action” (Adler and Kwon, 2002: 17). Resources, both tangible and intangible, are shared within a network of relationships. These relationships are characterised by cooperation and trust as people aim to benefit the greater good (or team objectives), which directly impacts their implicit ‘value’ for transacting the resources available within the network. However, the key challenge laid out by present studies of social capital is to appreciate how relationships can be organised and managed to not merely generate social capital but also to use it to ‘transact’ and ‘transfer’ knowledge and other resources that may go into shaping valuable innovation outcomes, that is relevant to both parties. There is also a lack of empirical examinations that consider the flows of resources across the whole network. Network theory provides a lens to empirically assess the transfer mechanisms of resources across and within a network.

Therefore, this section begins by providing a contextual discussion regarding the origin, context, and applications of social capital theory across disciplines. The section proceeding introduces how network theory is being utilized within organizational research, with a primary focus to reveal how (social) networks contribute to the generation of knowledge and innovation within organizations introducing the context and inter-relationship network theory and innovation outcomes, thereby illustrating the potential for social capital to be considered a strategic resource for firms and focuses on the issues of managing and coordinating social capital. It reviews how to unlock and sustain social capital for learning and knowledge generation and discusses the components and measurements typically employed in social capital research. Much research adopts a structuralism approach to analysis and focuses on the presence/absence, intensity, reciprocation, and role of the relational linkages that define actor position and predicts resource access within a network. While this study acknowledges that these components are important for fully understanding a network, this thesis argues that an over-emphasis on these structural properties may undermine the impact of contextual feature. These contextual features include the content of the relational exchange and networking behaviours conducted by the actors within the network. By examining a whole network, this thesis aims to understand how theories of networks might individually or in unison explain the process value creation in university-business coupled process of open innovation relationships.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

3.1 Chapter Introduction

The previous chapter presented the research questions and propositions that were utilized to guide the empirical chapters and the entire investigation. The aims of this chapter are to detail the research design and the strategies taken in the route to investigation. It begins with a brief review of the research objectives, as informed by the context in chapter 1 and the literature review presented in chapter 2. These chapters emphasized that there are clear theoretical differences between university-centred and the business-centred open innovation literature. It will then move to discuss the underlying ontological and philosophical positions of the researcher to explicate the core logic that guided the research design and methodological considerations for this study. The third section will introduce the research design, which adopts both an exploratory and descriptive phase. The section that follows will then introduce the methodology of Social Network Analysis as the research paradigm; which will provide a comparison to the more commonly adopted methodological approaches in social sciences, as well as how the network boundaries are defined, and the appropriateness of mixed method approach to collecting data. It will then look at the data collection methods used, employing multi-method qualitative and quantitative approaches. This chapter will then provide a brief overview of the data analysis techniques adopted, which includes social network analysis, thematic analysis, and a chronology. However, this thesis presents three different empirical chapters (chapters 4, 5, & 6). Each chapter adopted a different approach for analysis and will be discussed in greater detail prior to presenting the findings.

3.2 Objectives and Rationale for the Study

The purpose of this study is to characterise the complex nature of open innovation networks built between universities and business, and aims to illustrate the multi-relational channels and the array of influencing contingencies that contribute to the flow of knowledge and knowledge resources within such a dynamic social structure. As mentioned previously, open innovation is intended to promote the ease of access to new and exploitable knowledge stocks (Brown and Duguid, 1991; Chesbrough, 2003; Ketchen et al. 2005) as well as to leverage an organization's own internal ideas and paths to the market (Chesbrough, 2003). Through developing links with external partners, in comparison to traditional models of innovation that have been internally focused, an organization might be able to innovate to a much larger extent. As such, the open innovation literature frequently identifies universities as a potential partner in the open innovation process, however it frequently understates the

complexities of relational development and value creation with this partner choice. Thus, businesses require greater information and guidance on how to better engage with universities.

The literature review revealed that much of the current research depicts university and business relationships as mere external links that grant access to novel knowledge or financial efficiencies (e.g. Henderson et al., 1998; D'Este and Patel, 2007; Bruneel et al., 2009; Melese et al., 2009), with little attention has been given to the dynamic governance issues that surround the alignment of such diverse partners. For example, Chesbrough (2003) illustrates the potential for university and business collaboration in the context of an 'open innovation business model', but only briefly mentions the need to develop a relationship through a series of contractual agreements. Others have acknowledged the extent to which these diverse partners might encounter challenges in alignment, but have focused on the necessary usage of intermediaries (Huizingh, 2012; Wilson Report, 2012). This portrayal in the literature indicates a prevailing assumption that this relational type is complex, yet extant research has primarily focused on the transactional nature of these relationships which are predominately governed by formal coordination mechanisms (such as contracts, and neglect the other aspects such as trust). This portrayal in the literature indicates an assumption that mere economic incentives alone are deemed sufficient relational aspect of value creation within the relationship.

The objective of this study is to reveal the social and relational complexities of this innovation network type, and extend the conversation on open innovation and university-business literature to include the work on knowledge, knowledge generation, and knowledge resource flows found within the realms of innovation theory and strategic partnerships. The linkages that drive a network structure are complex and are characterised by dynamic interactions (Nonaka, 1994) between formal and informal governance mechanisms (Wasserman & Faust, 1994). The primary objective of the university and business category of relational dyad is to generate knowledge and knowledge stocks, but the body of literature on these relationships remains largely divorced from how the body of literature on inter-organizational relationships. This research aims to understand which elements of university-business coupled open innovation relationships can be managed to contribute and sustain the generation of knowledge and novel outputs; particularly since not all circumstances can be defined by a relational contract (Ireland, Hitt, & Vaidyanath, 2002). The objectives of this study develop from the lack of empirical examinations into the open innovation and the university-business literature and to offer insight into the complex and dynamic aspects of relational factors in the generation of innovation outcomes.

This study aims to crystalize the relational context of university-business coupled (open innovation) partnerships through reviewing the structural properties, knowledge-based content, and behavioural mechanisms, as the literature review revealed that no one study has attempted to bring network structure, content, and behaviour into a single analysis. The intended outcomes are to further illustrate the contingencies that have the potential to be replicated, and those that might be dependent on localized conditions. This will be done through observing, identifying, classifying, and characterising the structural, compositional, and behavioural elements of an active network over time. Using network theory can bring new light to theorization about university-business open innovation and to advance this further, empirical evidence is needed to answer the research questions affiliated to this aim. The overall contributions of this study are to extend the body of literature on open innovation, particularly those which identifies universities as a potential innovation partner for businesses; which will have implications for managers, policymakers, and academics. This chapter will illustrate the research methods that have guided this inquiry and will discuss the approaches selected for research design, methodology, methods, and analysis techniques used in this study.

3.3 Philosophical Position

This section of the chapter aims to characterise this study's journey to knowledge and explain the philosophical position adopted by the researcher. Per Burrell and Morgan (1979), the underlying philosophical stance of the researcher requires the individual to make two fundamental assumptions in designing their research; the ontological and epistemological stances. Ontology is the philosophical study of the nature of being or, stated differently, the reality of existence, whilst epistemology is the theory of knowledge and what can be learned about that reality (O'Brien, 2007). The ontological and epistemological positions give rise to the methodological choices adopted by the researcher and, as such, are interdependent in nature. Each of these underlying assumptions influence the way that research is conducted and what is viewed as something that can be learned in the process of research (Hughes and Sharrock, 1997; Cassell & Symon, 2012). From these conventions, the researcher determines what new discoveries are accepted or rejected and guides the research design to fit with the way we view what can be learned (Griseri, 2013). Therefore, it is essential for the researcher to marry their research design and methodological decisions with their underlying philosophical stances as doing otherwise may result in reliability concerns about the research that is conducted. This section aims to explain the underlying the philosophical stances that characterise this study in turn.

There are two polar extremes of the philosophical spectrum that a researcher may adopt; objectivism and subjectivism (Burrell & Morgan, 1979). The ontological and epistemological approaches lie within a continuum between the subjectivism and objectivism arguments (Hughes & Sharrock, 1997); with positivism representing the objectivist stance on one end and interpretivism representing the subjectivist position on the other (Deshpandé, 1983). The adopted position between these two schools of philosophical thought largely influence the ways in which the researcher believes that knowledge can be discovered and influences the strategies and tactics employed to gain knowledge through the learning process.

The objectivist believes that the individual is independent of the object being studied and, therefore, adopts a positivist epistemology to 'measure' the subject being studied (Reichardt & Cook, 1979). This philosophical approach is derived from the traditional scientific methods that have been successfully employed in understanding the natural world. The researchers that adopt an 'empiricist' belief in that the social world can best be understood through similar processes of reductionism of observable constructs. The construct can then be distilled, categorized, and measured to illustrate the fine grain components of a phenomena (Reichardt & Cook, 1979) for wider generalizability (Huff, 2009) through deductive reasoning. The researcher aims to remain detached from the study so to not impose their own attitudes or beliefs in the interpretation of the truth being revealed and avoids imposing any influence on the subject being studied. These researchers typically employ quantitative and statistical methodologies which characterise the objectivism and positivist end of the philosophical continuum. They search for the mechanistic and deterministic (cause and effect) mechanisms to predict behaviour (Burrell & Morgan, 1979).

A pure positivist rejects the potential for unbounded phenomena as a means for knowledge creation. Hence, emotions or attitudes, among other constructs within the realms of psychology, are irrelevant as these 'internal' concepts are difficult to measure objectively and infallibly. However, this approach is not without criticism. Those against the objectivist position state that purely objective and quantitative approaches can frequently ignore some of the fine grain contextual details that can only emerge from deep engagement within the research subjects (Burns, 2000; May, 2001; Byrne, 2002) and over relies on rationality (Delanty, 2000). These researchers' agree that human complexity can be unbounded, which cannot be explained in purely objective terms.

On the other hand, the subjectivism ontology is supported by those that argue that the social sciences are relative due to the complexities and unpredictability of human nature (Silverman, 2015). The social world can only be understood through the interpretation and the meaning that an individual attach to the object, subject, topic or phenomena under research (Cassell & Symon, 1999). This argument contends that the social world exists only within the mind and, therefore, the methods of inquiry must allow for localized interpretation for the interlinkages of behaviour and the situational contingencies (Cassell & Symon, 1999). The interpretivism or constructionist epistemologies surrounding this philosophical stance are those typically characterised by researchers who adopt a qualitative methodological approach (Burrell & Morgan, 1979). Qualitative methodological approaches view the researcher themselves as a vessel for the interpretation of the phenomena being studied. The researchers seek to attribute meaning through direct interaction with and observation of the human subjects, allowing for the fine grained contextual details to emerge in an inductive or deductive way. It is their belief that the social world can best be understood by identifying the symbolic meaning and interpretations that the subjects attach to the contexts being studied through submersion in the field setting.

The subjectivist school has been criticised for its over-reliance on generalizations that are limited to purely local conditions (Huff, 2009). Due to the acknowledgement of human complexities, the subjectivist approaches lack a systematic and standard method towards the interpretation generated. This school of thought is criticised for the degree of interpretation that is evident in the generalizations and has greater potential to be influenced by the cultural and behavioural biases held by the researcher. The interpretations have potential to reveal underlying biases which, therefore, face reliability concerns (O'Neill, 1995). The debate between the two polar extremes of the spectrum often results in a researcher defining preferential attachment to a specific position and the rejection of the opposing philosophical stance (Burrell & Morgan, 1977). This debate is often characterised with either side of the debate claiming superiority over the other. However, this study acknowledges the potential benefits for acknowledging duality within these varying philosophical perspectives and what can be known about the social world.

The researcher who has adopted an intermediate position and aims to invoke the strengths of both approaches to address the potential deficiencies and enhance the reliability of the findings on either end of the philosophical debates. Burrell and Morgan (1977) refer to this approach as an intermediate position which allows “for the influence of both situational and

voluntary factors in accounting for the activities of human beings” (Burrell & Morgan, 1979: 6). This approach is most frequently associated with critical realism and adopts a mixed methodology. It acknowledges that imperfections in data collection and interpretation techniques can be benefited from both objective and subjective interpretations. As suggested by Gill and Johnson (1997), the researcher aims to derive knowledge triangulating these positions through a mixed methodological approach.

Within this belief, the researcher adopts a post-positivist approach to deriving social facts to be measured and categorized from some phenomena whilst also acknowledging that the complexities of human nature are not entirely absolute (Marsh, 1982). This is indicative on the level on inaccuracy in reporting and recalling historical facts, and therefore requires degrees of interpretation (Aram & Salipante, 2003). To adopt this approach, the researcher accepts the possibility for social relations to be studied using the same systematic methods employed by the natural sciences and uses the qualitative data to “define the situation” (Silverman, 2015) whilst also acknowledging that findings and evidence will require a degree of interpretation. The research design has been built to address this philosophical position. As the researcher, has adopted an intermediate (critical realist) philosophical position, this study employs a dynamic research design that includes a preliminary exploratory phase with a proceeding descriptive phase.

3.4 Research Design

The section of the thesis addresses the research design considerations that were employed to investigate how knowledge flows within a network. As introduced in the literature review, no one study has brought together network structure, content, and behaviour in a detailed analysis of how value is created between partnering organisations (particularly that of university-business open innovation relationships). There are many socially complexities in the alignment and knowledge transfer between and among university-business open innovation relationships and this thesis posits that current recommendations made thus far, about the effective organisation, operation, and management of university–business collaborations, are leading to an incomplete and abstract view of how value is and is not created within these partnerships. The design of the investigation was aimed towards crystalizing the relevant contextual conditions and components that contribute to the flow of resources. Therefore, it adopts two different phases; an exploratory phase and a descriptive phase.

The first phase of the research design adopted an exploratory stance that was aimed at deriving the contextual details of the relational channels and the various attributes of the actors embedded within the network structure (Wasserman & Faust, 1994). An exploratory study aided in the conceptual development of the potentially novel constructs to be tested at the later stage. The benefits of this research design in the early stages is that it allowed for flexibility so that looks potential discoveries and variables emerge due to the less stringent methodological requirements (Yin, 1994). This stage utilized multi method qualitative approaches that enabled triangulation among data sources and aimed to increase confidence in the reliability of the overall discoveries created. Hence, the purpose of this stage was to gather evidence of the various components of the inter-organizational relationship and to define the prominent themes that could later be utilized in the development of the quantitative testing phase.

The second stage of the research design adopts a descriptive stance in that it then seeks to measure and describe the influence of the contingencies that were revealed during the preliminary exploratory stage. The descriptive research design seeks to crystalize the network structure of a particularly successful example of a university and business relational dyad in its entirety. The intended outcome is to describe the ways in which novel and innovative outputs might be organized to influence outcomes from within an active network in a systematic way. Per Churchill (1999), a descriptive research design is best applied when the research topic is focused on revealing the characteristics of social groups and the relationships between variable. This is necessary to illustrate the complex dynamics and interactions among network structure, content, and behaviour on both sides of an open innovation relationship dyad. Therefore, the descriptive phase adopts both qualitative and quantitative techniques to data collection to allow for triangulation to enhance the reliability of the interpretations.

There are two different formats of descriptive research designs: longitudinal and cross sectional. This study attempts to gather information on both formats of descriptive research designs. Longitudinal research designs are a study that aims to observe the phenomena in question over a period to track dynamic changes (Balnaves & Caputi, 2001) in order to derive greater insights on the object, subject, topic, or phenomenon being studied. The longitudinal lens is aimed to provide insights into how a network might evolve over time. By reviewing archival documents, the oscillation of network members and the effect of network size can be mapped in accordance with significant events in the relationship's history. The cross-sectional survey design aims to collect information regarding the phenomena at a specific point in time. This is the most common method for social science data collection and typically takes the

format of a survey (Bryman, 2001) but faces criticism as it leaves the researcher disengaged from the data collection. The survey constructed for this study aimed to understand and measure the prevalence of informal social capital, reciprocation of the relational exchanges, knowledge sharing behaviours and how value creation is assessed, well as the cohesiveness of the overall structure. This survey will also seek to reveal the categorical dependent variables to further categorise aspects of human behaviour and the level of social capital held by the actors (Long Scott, 1999). The aim will be to characterise the level of involvement that each actor displays, the cohesiveness and density of the resource flows within the, the elements of behaviour that characterises the actors, the extent to which external institutions pressurize the internal functioning of the network, and the extent to which an actor's social capital is transferred to the network.

To achieve the aims and objectives of this study in this context, social network analysis (SNA) methodology has been adopted to map the regular patterns of interactions and their implications (Wasserman and Faust, 1994). A comprehensive social network analysis (SNA) will reveal the contingencies of how the knowledge and knowledge resources flow between relational channels within this network. Social Network Analysis differs from standard social science techniques in fundamental ways. Whereas standard approaches to analysis focus on actors and their attributes, SNA focuses on the relational patterns and their influences. The next section will introduce the social network analysis paradigm, and how this method seeks to explain the social phenomena of interest and how this approach was chosen over other social science methodologies.

3.5 Methodology: Social Network Analysis

Social network analysis was briefly introduced in 2.5.2.1 as the methodological approach taken for this investigation and its alignment with social capital and network theory research paradigms. The theories and application of the social network analysis paradigm diverges from objectives of the most commonly applied social science approaches, in that it deviates in regards what and how the data might reveal phenomena of interest. For instance, standard social research methods aim to illustrate the importance of interactions between independent variables and observation. The data collection methods are designed to be collected from specific populations and are structured in way that the analysis will enable generalizations on a large scale. A social networks analysis focuses on the inter-relationship how the actors and their actions are embedded within the phenomena of interest and how interactions and influences are characterised within a variety of relational structures. It is the

mapping of the interdependency within a social system. Through collecting, observing, and analysing individual behaviours, attitudes, or beliefs within a network, this form of analysis aims to reveal how interactions constitute structure that can be studied (Galaskiewicz & Wasserman, 1994; Hanneman & Riddle, 2005). This approach varies from the prevalent method and forms social research methods, in that it adopts an approach that focus on the usefulness of components (e.g. nodes and ties) and the influence they might have on the phenomena of interest (Wasserman & Faust, 1994; Prell 2011). The focus is on defining patterns of relationships and group dynamics from a more macro level view, rather than looking inwardly to the individual. The development of network approach across discipline (Freeman, 2004).

This approach emphasizes the importance of identifying the influence of interdependency in relational processes and how various components embedded in a network can describe and predict not only the collective performance of the phenomena of interest but also individual actor level behavioural and outcomes (Hanneman & Riddle, 2005). This is achieved through the identification of regular interaction patterns between actors, who are then further characterised by their position and ability to influence structure of relations. The relational linkages between actors serve as conduits for the resource flows (Granovetter, 1985; Burt, 1995). This analysis technique seeks to identify the prevalence of specific types of relations that enable (or constrain) the social activity that defines the network. Through mapping the various relational linkages that exist within a network structure, the research can pinpoint specific areas of interest that exhibit opportunities and constraints within the flow of resources.

The concept of how social networks influence group level phenomena is often attributed to the work of a German sociologist by the name of Georg Simmel (1908). Simmel recognized that the interaction patterns which exist within a structure of social relations is that which defines society (Freeman, 2004). It was his belief that the structure of social relations largely influences individuals and their behaviour, but also the interaction between people create social phenomena in a cyclical way. His work paved the way for the interpretivist approach within the social sciences and is typically characterised through qualitative investigations. However, later developments in the social network analysis theory presented a systematic approach for social network data collection and analysis to be presented in an objective way. Moreno and Jennings (1934) introduced the approach of visually displaying the presence and absence of social relations in matrix and graph forms. Their influential work introduced what is called the adjacency matrix and is of how network data continues to be

analysed today. The adjacency matrix (also called a socio-matrix) and socio-grams allows researchers to employ a systematic method for presenting the patterns of social network data in a compressed way (Hanneman & Riddle, 2005).

Social Network Analysis borrows concepts from graph theoretic notation and relational algebra, which is used to visually display network connections and to serve as information maps in identifying the significant features of a social structure. This approach adopts specialized terminology and concepts from graph theoretic notation and allows for a positivist approach in which the researcher is focused towards understanding and presenting the social facts, and measuring the influence of specific constructs using statistical modelling (Cross & Parker, 2011; Hanneman & Riddle, 2005). This approach seeks to be objective and measures the intensity of the varying social relations that may emerge from a qualitative investigation in a way that is consistent with the scientific methods employed within the natural sciences (Kuhn, 1964) as well as acknowledging that the network includes local conditions (Wasserman & Faust, 1994). The observations and analysis can be further refined to include various behavioural characteristics of the individual actors, can be used to define compositional elements, and helps to categorize specific the composition of the social systems (Wasserman & Faust, 1994). The primary objective of this stance is to reliably present consistent and objective information with regards to the topic researched to create the rich descriptions of the relational patterns (Hanneman & Riddle, 2005).

Although this research paradigm diverges from the standard social science approaches within the analysis process, the commonly accepted data collection techniques are still employed. SNA is most benefited from robust data collection as the outset of a social network investigation requires rich descriptions of the relational patterns before further analysis can commence (Hanneman & Riddle, 2005; Robbins, 2011, Prell, 2011). In light of this fact, a broad range of collection techniques was utilized to enhance confidence in the stated generalizations. The data collection techniques are similar to the common social science approaches in many respects (Hanneman & Riddle, 2005). However, the basis for analysis and how observed data are interpreted vary in the underlying assumptions that studies may seek to address.

Data for the adjacency matrix may be derived from a variety of sources and is largely contingent on the relationship that is being defined by the researcher (Wasserman & Faust, 1994). For instance, a binary adjacency matrix allows a researcher to chart the presence and/or

absence of relational tie. This information can be retrieved from the collection of both qualitative and quantitative data collection techniques. A more advanced adjacency matrix may also employ valued or ordinal scales to reveal the intensity of specific relations. For instance, the richness of the qualitative data collection allowed the researcher to develop several socio-graphs and socio-matrices based on the coordination documents and may allow some sections to drawn freehand from the evidence presented. However, triangulation between observational techniques, archival documents, and participant accounts increases the reliability of assessing the nature of the genuine network structure. To ensure accuracy and address the concerns of informant accuracy, data collection has been approached through a mixture of both qualitative and quantitative techniques. To (Bernard & Killworth, 1977; Wasserman & Faust, 1994). The robustness of the mixed method approach seeks to allow a true representation of the network activity. The next section will illustrate the research journey.

3.6 Methods for Data Collection: Mixed Methods

This section will focus on the procedural steps that aimed to categorize the network actors, the content of their knowledge acquisition motives and goals, their roles within the network, who they frequently connected with whom, and how they communicated (Carrington & Scott, 2012). SNA is most benefited from robust data collection, as the outset of a social network investigation requires rich descriptions of the relational patterns before further analysis can commence (Hanneman & Riddle, 2005). Defining these features of a network structure aids researchers to understand concepts such as the density of social relations and the ease at which individuals work together (Hanneman & Riddle, 2005) to enable an understanding of how opportunities or constraints may emerge in the social structure (Granovetter, 1985, Burt, 1992; Adler and Kwon, 2002). The data collection techniques were designed to fully immerse the researcher in understanding the functional elements of the whole network and the mechanisms that drive innovation performance.

3.6.1 Qualitative Methods for Data Collection

Portions of this investigation focused on qualitative data collection techniques, which would allow for a deeper appreciation of the contextual factors that might not be immediately evident through a quantitative investigation alone (Silverman, 1993; 2015; Miles & Huberman, 1994). The volume of events and data collection opportunities was extensive, and the researcher needed to use judgement to appropriately define the level of involvement that was possible. However, the researcher must obtain rich data sets from a variety of sources (Hanneman & Riddle, 2005; Wasserman & Faust, 1994). This required the researcher to adopt

a level of flexibility to ensure that data collection was robust but this also provided the benefit of reflexivity in the research process. This enabled an iterative and recursive approach to pursuing field experiences based on access and development within the relationship. This is important when the body of theory and literature on how relations might work successfully is largely fragmented (e.g. Andersen & Christensen, 2005).

The aim was to capture complete descriptions of the topic being studied and the contextual conditions that may not be evident from a solely quantitative analysis and to facilitate an unbiased emergence of relevant constructs, as well as aid in identifying causal links between constructs and antecedents that contribute to the performance of this collaboration for the subsequent phase of the investigation (Miles & Huberman, 1994, Yin, 1994). Studies that seek to characterise the differences in how well connected an individual is within a network is consequential for understanding the opportunities (and constraints) that are available within the network. The study is set within an active network, which provided many opportunities to collect data during periods of dynamic change (Castilla, 2007; Yin, 1994). This form of investigation enabled the researcher to delve deeply and intensively into the phenomenon of interest in its natural setting (Burns, 2000), helping to reveal additional factors not originally included in the theory (Eisenhardt, 1989). The researcher adopts a subjective stance and unavoidably serves as an instrument in the research design as objective and external instruments cannot reveal or aid in inferences about the behaviours observed or the contextual conditions of the conversations held with participants (Spradley, 1979). Through studying the contextual conditions that influence “the meaning that people attribute to the “real world conditions” and allows the story to unfold in its own way (Yin, 1994: 4). The extensive collection of qualitative data that was collected allowed the researcher to begin to develop the descriptive phase of the research. This allowed the researcher to plot a socio-gram of task interdependence utilizing the connections that emerged from the varying sources of qualitative data. The archival documents and participant accounts allowed for a longitudinal lens of the development of the network over time.

3.6.2 Quantitative Methods of Data Collection

Quantitative techniques are applied to further characterise and measure such things as the intensity of interactions across the range of relational linkages, the level of cohesiveness or cluster ability that is derived from the qualitatively focused aspects of the investigation. This collection technique might focus on deriving scaled measures to indicate intensity or the degree of reciprocation. The data derived can be mathematically and graphically represented to display

and pinpoint specific areas of interest within the overarching network structure. Networks with few connections lack in solidarity and tend to fall apart (Hanneman & Riddle, 2005). However, Burt (1995) argues that these weak connections (also known as structural holes) provide the network for novel information. Software systems UCINET, Pajek, and Netdraw was employed for a portion of the network that were clearly identified based on the actor's obligatory relational ties. In addition, the cross-sectional survey collected several independent observations to give greater depth to the node (actor) compositional elements and to develop descriptive statistics.

3.6.3 Ethical Compliance and Research Integrity

Prior to the beginning of the investigation, considerations were made towards ethical compliance, which pose significant challenges for network researchers. Research involving human subjects within the social sciences typically follows ethical compliance and in which anonymity is guaranteed. Additionally, these studies focus on large scale data collection or generalizability to larger populations, which also aids in the task of ensuring anonymity (Kadushin, 2011). The network analyst differs in respect to what they seek to collect information; such as who relates to whom and how. This approach reveals variances within the network structure that might have implications for those that know where certain network members sit within the organization (Borgatti & Molina, 2003; Moreno, 1938). This potential issue was addressed by including all members of the network in the analysis to create a level scale for anonymity. Additionally, actors were assigned anonymous identification codes in the data reduction phase. The researcher is the only person with access to the master database.

The confidentiality of the network was addressed in the format of the anonymization process. This umbrella master agreement required that strategically sensitive would be reviewed by the industrial sponsors prior to publishing to ensure that strategically sensitive information was not revealed. Additionally, research ethics had been considered and consent was granted in accordance with the Durham University published research ethical guidance, which is aligned with the British Psychological Association guidelines. (Please see appendix for a completed flow chart and check list.)

All participants were informed of their rights, which included their ability to refuse to answer any questions, omit answers from the final transcripts, and their right to withdraw from the study at any time. They were provided with a project information sheet, which included details of the study and the ongoing opportunity to refuse consent. The benefits of the study

emphasised the contribution to the collectively in which their answers would allow the relationship to be enhanced (Kadushin, 2011). (Appendix 1)

Interviews were audio recorded and later transcribed. Observations were not audio recorded, however field notes were taken and later transferred to a digital format to be stored in the study's database. Documents were also labelled and stored in a similar format. During data reduction, evidence was summarized, anonymized, and compiled into a database for coding and theme identification. Participants in the survey data collection phase were provided with an overview of the research study and informed consent prior to initiating a response (Appendix 2). Data was collected electronically via Qualtrics and each participant was assigned anonymous ID code, identifiable only by the primary researcher. The next section of the chapter will discuss the units collected for analysis, which employs a holistic view of a single case study as well as the appropriateness of this technique.

3.7 Application of the Holistic Case Study Approach

A holistic view of the whole network was selected as the unit of analysis for this case study. This was to view the both the overarching structure and the micro-level interactions that occur within the boundaries of the contractual relationship to characterise, and to further characterise how the opportunities and constraints to knowledge resources may (or may not) occur within the immediate network structure. Per Yin (2009), a holistic case study allows the researcher to derive meaningful characteristics and descriptions of the phenomena being studied. This approach offers several advantages, such as providing a complete description of the topic being studied and disclosing contrasting positions without imposing the researcher's personal biases (Silverman, 1993) and yields benefits of uncovering disparate positions within a real-life context in that it adds meaning to the characteristics of contemporary phenomena, and are more appropriate for how and why questions (Stake, 1993). This is especially true "when the boundaries between context and phenomenon are not clear" (Yin, 1994: 13). A macro level view was adopted to describe general features of the relational dyad that was built between a functioning university and business relationship, but the thesis also focuses on complex and micro level process and the variety of relational exchanges that are embedded within this network.

Therefore, this approach aided in unfolding the varying conditions that contributed to how the relationship has developed over time and how the implementation of the conditions may have resulted in various developmental outcomes, how these conditions have contributed

to the multi-faceted levels of each of the parties' experience. The approach taken followed a purposive sampling technique in that the case selected for the investigation is active and productive in an atypical way (Silverman, 2015). The next section will present the research site chosen for this investigation and illustrate the appropriateness of selecting a single case study for the research design. The case study selected is cited as unusually high functioning. As suggested by Stake (1995) this case has the potential to provide rare insights warranting its study and can be instrumental to inform other case studies. Hence, it provides a compelling backdrop for analysis.

3.7.1 The Research Site

This study will focus on analysing both sides of functioning and high performing open innovation relationship dyad that has been built between Durham University (DU), a public collegiate research Higher Education institution based in Durham, England, UK and Procter & Gamble (P&G) a transnational consumer good company headquartered in Cincinnati, Ohio, USA. The relationship that has been built between these two organizations has been frequently cited as a highly successful partnership by both parties as it has generated a value more than £20M, leveraging over £10M in Government and Research Council support, with over 66 funded projects and over 180 people involved in the collaboration.

This Durham-P&G model was also cited as a case study in the Wilson Review (2012) report to the U.K. Government. Additionally, Jeff Weedman, Global Business Development Vice President of P&G, cited this relationship to US Congress in February 2012 as the exemplar for industrial engagement and praised the “fascinating” approach taken by Durham University in its collaboration with P&G. This presentation was part of the National Governors Association conference on ‘Creating an Entrepreneurial Culture’ in 2012. Moreover, in an open letter to Prime Minister David Cameron on 5th November 2012, Bruce Brown, Chief Technology Officer at P&G, specifically highlighted its “powerful collaboration” with Durham University as an example of a highly successful relationship that helps P&G maintain its competitiveness and innovativeness despite rapid scientific advancement and encroachment by competition.

P&G originated in 1837 in a partnership between candle-maker, William Procter, and soap-maker, James Gamble (Marketline, 2013). The rich history of this 178-year-old company boosts a long line of innovation and adaptation to market conditions. In 1930, the company adopted an internationalization strategy through the acquisition of Thomas Hedley Co. in Newcastle upon Tyne, England, UK (P&G, 2015). This acquisition served as the initial entry

into laundry care and international markets. Today, they are one of the world's largest consumer goods companies with an approximate \$85 billion net value, 26 billion dollar brands, and a product portfolio mix that touches 4.6 billion consumers in 180 countries daily. The company operates a matrix structure with global operations spanning into 80 countries and 26 innovation centres around the globe.

Durham University was granted royal charter in 1837 and has claims to being the third oldest university in England (Durham University, 2015). The university has a distinguished global reputation, with Times Higher Education and QS World Rankings consecutively identifying the institution in the world's top 100. The annual turnover is approximately £65 million, with about 16,000 students attracted from 160 countries. The university is divided into three main faculty focuses, Social Sciences and Health, Arts & Humanities, and Science, with twenty-four different departmental disciplines.

This relationship has developed to include members from the Chemistry, Physics, Biology, Psychology, Engineering, and Business School departments within Durham University; as well as 6 of P&G's innovation centres located in the United Kingdom, the United States, Germany, Italy, Brussels, and China. This influence also extends to administrative and managerial functions within both organization. Additionally, the relational dyad has also had an impact on a variety of external stakeholders; which include an excess of over 40 partner SMEs, MNCs, partner universities, and public bodies. Therefore, the extent of the network activity might include an extensive number of actors. However, this investigation defines the boundaries to include actors that have an 'internal' influence on an active network's most regular functioning coordination, maintenance, and productivity.

Each partner recognizes that the development and scale of the relationship has been built in an organic way. Yet, the success factors, the self-organizing processes, and how this relationship gained the momentum to build critical mass and efficiencies requires further examination. Considering this evidence, P&G now wish to understand how and why this relationship works so well and the mechanics of it so that they can benchmark it and scale this model of collaboration worldwide. For Durham University, the success of this relationship has generated a similar desire to understand how and why this relationship operates effectively to enhance its own strategies towards future university–business collaborations. Thus, this research site has been exceptionally congenial to data access.

3.7.2 Informants

Key informants were identified for semi-structured interviews in the early stages of the research project. This was done via a cascading strategy and snowball procedure for identifying access to other data points, and for identifying participants across a variety of roles and network coordination levels. The participants identified further people involved in the relationship at both Durham University and P&G at an overarching level, followed by a cascade down strategy towards individual participants at a project level enabling triangulation (Yin, 1994; Miles & Huberman, 1994). To address construct validity, data collection involved multiple participants at varying organizational roles were sought to address the potential weaknesses through triangulation.

Most qualitative data collection was geographically accessible through flexible scheduling around other commitments located on the University site. However, a couple web-based interviews were conducted, a visit to two P&G locations, their headquarters in Cincinnati, Ohio, and the Newcastle Innovation Centre. Where appropriate for data validation or clarification, interviewees were approached for a second, follow-up interview (Miles & Huberman, 1994; Gephart, 2004). The archival documents were collected from the research participants.

The quantitative data collection was collected electronically via Qualtrics. The participants were in several geographic locations and were emailed a password protected link. All participants were provided with an overview of the research objectives and agreed to the informed consent prior to initiating the survey. They were guaranteed anonymity, but could withdraw their participation at any time.

In the remainder of this thesis, the reference to the study participants will adopt the social network analysis terminology of actors. Social entities can also be referred to as actors (Wasserman & Faust, 1994) within the social network literature. Typically, the term actor can extend beyond individual units and can be used to describe social units. This relationship has a variety of social units corresponding dependent on the knowledge goals of the unit. For the sake of clarity, these units will be identified as departments. The term of actors will be used to identify specific individuals/participants in the study.

3.8 Overview of Data Collected

As mentioned previously, social network analysis requires a robust level of data collection and therefore adopts mixed methods to collecting both primary and secondary

sources of evidence. This section will illustrate the techniques utilized for the primary data collection (which includes participant observations, direct observations, semi-structured interviews, and surveys) and the secondary data collection (which includes archival documents). The below figure provides an overview of the data collected for this study.

Figure 7 - Overview of Data Collected

Primary or Secondary	Classification of Core Assumptions	Sources of Qualitative Data	Quantity
Primary	Participant Observation/Interpretivism	Board Meetings	14
	Participant Observation /Interpretivism	Semi-Structured Interviews	15
		Informal Meetings	9
	Direct Observation/ Positivist/Interprevistism	Cement Technical Meetings	18
		Public Presentations	2
	Postivist	Survey	223
Secondary	Positivist/Intrepretivism	Archival Documents	94

3.8.1 Primary Data Collection

This section of the methodology will discuss the sources of primary data collected during the qualitative investigation. Primary data is characterised as data collected for the principal usage of the study by the researcher (Glass, 1976; Chruchill, 1999). This collection exercise was achieved through various approaches to field observations, interviews, and archival documents and, therefore, utilized a multi-method qualitative approach. As mentioned previously, the site was exceptionally congenial and allowed substantial access for data collection. The figure below provides an overview of the qualitative data collected.

Field observations continued throughout the length of the project. As suggested by Maxwell (2009), these repeated observations and intensive long term involvement with the participants aided in the development of an in depth understanding of the field setting. As suggested by Miles and Huberman (1994) this provided the opportunity to collect rich data through gaining a “focus on naturally occurring events in natural settings.” This technique is frequently applied within anthropological studies with the intentions to understand cultural level phenomena (Silverman, 2015). Naturally occurring, ordinary events in natural settings to develop a strong understanding of what real life is like. There are four different variants to observing field data; acting a participant, acting as participant who observes, an observer who also participates, and/or simply observing (Schwartz & Schwartz, 1955; Gold, 1958; Yin 2013). This study adopted an approach that allowed the researcher to be participant observer in a real-world setting (e.g. the board meetings, the informal interactions, and the semi structure interviews) whilst allowing a passive role in other field settings (e.g. monthly technical meetings).

3.8.1.1 Direct Observations

The direct observations allowed the researcher to retain a passive role while observing interaction patterns and activities in a natural setting. This allowed for the researcher to observe the interaction patterns among the actors within the setting without interfering in the overall design of the event (Silverman, 2015; Yin, 2013). To ensure confidentiality of the content being shared, the direct observations were not digitally recorded. However, field notes were taken. The direct observations were collected through the attendance of monthly technical meetings within the Chemistry Department at Durham University and two presentations that were focused on the relational content for public audiences. The technical meetings were held on the first Tuesday of every month. The format of these meetings served as a forum, where students could present the progress of their studies and receive feedback. These events were open to anyone that was involved in any of the projects, however these meetings were most regularly attended by the network’s internal members of academic staff from Durham University and technical managers from P&G. The room had a wide range of expertise, but the volume of participation varied for each of these meetings. After ‘business’ updates, the PhD student would present a 30-45-minute presentation on the current findings, methodology and progress of their project. This was followed by question and answer session that allowed observers to offer feedback. The observers would engage in an open dialogue about potential solutions to next steps and engage in joint problem solving that would carry on for an average of 15-20 minutes.

There was also opportunity to conduct direct observations through the attendance at two public presentations. P&G developed the presentations to discuss the implications of network activities.

The benefits of this form of observation is that it reduces the risks of social desirability responses by the participants (Myer & Lamm, 1976) and allows the story to unfold in its own way without the researcher imposing influence on the activities being conducted. This allowed the researcher to remain detached from the participants being studied and allowed for a more objective view.

3.8.1.2 Participant Observations

Participant observations borrow from anthropological approaches to research in that they focus on obtaining qualitative data first hand (Silverman, 2015) and usually over an extended period. This technique is typically applied when attempting to derive cultural conditions or meaning is focuses on understanding of the subjects through direct immersion in research site whilst also allowing researcher to engage within the interaction to derive meaning (Yin, 1993). Bryman (1988) states that approach offers benefits within flexible research designs when the research aim is to contextualize and describe phenomena.

Participant observations were conducted through the attendance of the regularly scheduled board meeting. The board was composed some key strategic leaders within P&G and DU. From P&G, attendance included a Director, two Technical Managers, and Finance Manager. From DU, attendance included the Pro-Vice Chancellor, a Director, three Heads of Department, myself, and an Intern designated to handle administrative functions. The primary focus of these meetings was on strategic planning and resource allocation for future initiatives, as well as addressing potential institutional pressures through reviewing and responding to external communications. These meeting were not recorded; however, field notes were permitted. This technique for data collection allowed for the researcher to derive deeper meaning from the observations as it allowed the opportunity to ask questions and allowing for moderate participation in the research setting.

3.8.1.3 Semi-Structured Interviews

The section will illustrate the collection of the interview data. Interviews provide several advantages in the collection of data in that it allows the researcher to gain information on topic specific content. There are three main techniques to conducting an interview; open ended, semi-structured, or fully structured. The open-ended interviews are most suitable for

researchers that aim to pursue a naturalistic approach (Silverman, 2015). (Appendix 3 – Interview Protocol).

Figure 8 - Overview of Semi-Structured Interview Participants

Organization	Title	Expertise Area	Role in Network
P&G – NCL	Director	Physics	Coordinator (Top)
P&G – London	OI Manager	Chemistry	Coordinator (Biology)
P&G – NCL	OI Manager	Chemistry	Coordinator (Chemistry)
P&G – NCL	Tech Mang.	Chemistry	PI
P&G – USA	OI Manager	Chemistry	Coordinator
P&G – USA	Director	Biology	Coordinator (Top Biology)
P&G – USA	OI Manager	Biology	Coordinator/PI
P&G – USA	Tech Mang.	Chemistry	PI
DU- DBIS	Director	Chemistry	Coordinator (Admin)
DU- DBIS	Director	Physics	Coordinator (Admin)
DU- DBIS	Intern	Biology	Coordinator
DU	Head of Dept	Physics	Coordinator/PI
DU	Pro Vice Chanc	Physics	Coordinator/PI
DU	Head of Dept	Chemistry	Coordinator/PI
DU	Head of Dept	Biology	Coordinator/PI

Semi structured interviews were focused on understanding the role of key actors and used to identify the actors' history with the relationship, their views on the inner working of the network, how it formed, significant events, challenges, and benefits, and what they thought were the highest functioning aspects of the relationship to further contextualise how and why the relationship formed and is maintained. Interviews were conducted with open ended questions to prevent steering of the responses and to allow for conversational mode to understand the participant's world and views of the relationship more deeply. As suggested by Silverman (2015), this format allowed the actors to make authentic representation of their views of the world and vocalize their priorities whilst allowing the researcher to be non-directive and remain neutral. As part of the protocol, a template of questions was aimed at understanding how the relationship was built. The interaction was thus constructed through

interactive dialogue and additional questions were asked to address potential multiplicities of meanings, thereby addressing the potential for duality and multiplicity of meaning in the emic and etic perspectives.

Fifteen semi-structured interviews have been carried out involving key personnel within P&G and Durham University working within the relationship, both in the United Kingdom and the United States. Semi structure interviews were focused on understanding the role of the key actors. This included the actors' history with the relationship, their perceptions as to the inner workings of the network coordination, how it formed, significant events, challenges and benefits. The interviews were audio recorded and later transcribed. All field notes were later transferred to a digital format. All documents were summarized and compiled into a formal database. The evidence relevant for analysis was extracted and summarized into the database, allowing for tabularization per first and second level codes as well as to account for the frequency of events.

3.8.1.4 Pilot Interviews and Informal Interactions

The purpose of a pilot interview is to the help to refine the data collection plans and the semi-structure interview protocol. The benefits of utilizing pilot interviews are that it helped to refine the semi-structured interview protocol as well as to identify the initial gatekeepers and relevant actors to begin the snowballing technique to finding additional informants. There were two pilot interviews that were conducted during the early phases of the research. One interview was held with members for either side of the relational dyad, one from Durham University and one from P&G. The pilot interviews were not recorded; however, field notes were taken and later transferred to a digital format for safe keeping in the study's database. These early discussions were focused on building repertoire with key gatekeepers. These also aided in gaining access to other data collection opportunities. Additionally, several informal interactions were documented. Several Informal Interactions were documented from observations made in the field.

3.8.1.5 Cross-Sectional Survey

The final approach to collecting primary data will adopt a positivist stance and seeks to utilize the mathematical approached applied within the realms of social network analysis. The survey will aid in the descriptive phase of the research. Therefore, this section will focus on the quantitative approach to deriving knowledge. The survey data included the entire population of individuals at Durham University and P&G involved in the relationship in any way. Targeting the entire population excludes the occurrence of sampling errors (Murphy,

2002). Therefore, a survey was utilized to collect compositional data to further characterise the multi-relational linkages as perceived by the actors involved within the boundaries of the entire relational dyad.

The final stage of the data collection sought to develop a survey to understand the intensity of specific relational ties by utilizing a valued scale measurements. Therefore, the quantitative investigation adopted an ego-centric approach to the data collection not only to further identify the relational linkages but also to identify some of the human capital elements that influence the development of the network structure. The act of intentional influencing is a largely individual behaviour. This survey is aimed towards understanding the informal networks. Survey design protocols by Dillman (2000), Podsakoff, MacKenzie, Lee and Podsakoff (2003), and Spector and Brannick (1995) among others were followed. (Appendix 4 – Cross Sectional Survey)

3.8.2 Secondary Data Collection

Additionally, there has been considerable access to coordination documents and databases, which allowed for secondary data analysis. These documents were intended for the management and coordination of the relationship and have allowed for a longitudinal lens into the transactional/formal coordination of the relationship and the organizing techniques dating over a period of four years. Secondary data is characterised by the re-analysis of existing information for the purposes of the questions at hand (Glass, 1976). These were collected from internal documents, presentation materials from workshops and conferences, as well as information displayed in the public domain, such as press releases, books, articles, and website information. The benefit of retrieving the archival documents was that they augment evidence for other sources to reflect the corroboratory versus contradictory evidence (Wasserman & Faust, 1994). The collection of archival documents allowed the researcher to retrieve objective data with regards to members of the network and the relations that exist per contractual coordination.

Figure 9 - Composition of Secondary Data Sources

Sources of Secondary Data	Intended Audience
Board Meeting Coordination Documents	Internal to the board only (Sub-group within the network)
Case Study Dossier (Created by DU-P&G Intern	Institutionally Sensitive (Open System)
Public Press Releases	Public (Open System)
Relationship Coordination - Internal Documents	Whole (Internal) Network (Evidence of subgroups)
Strategically Sensitive Documents – NPD	Institutionally Sensitive (Open System)
Financially Sensitive Documents	Institutionally Sensitive (Open System)
Presentations	Invitation Only – Public (Open System)
Previously Published Case studies	Public (Open System)
Other (Marketline reports, Financial Statements, Website Data)	Public (Open System)

3.9 Analysis Techniques

This thesis presents four empirical chapters. Each chapter provides a different overview of the various aspects impacting the networks found within the P&G-Durham University relationship; such as the development and management of the relationship over time, the influence and the management of external parties and networks, and the various relational ties among P&G and Durham stakeholders, formal coordination mechanisms are examined and in particular the transactional structure of the relationship, and the impact that behavioural components have on network performance.

3.9.1 Network Analysis and the Identification of Relational Context Components

As revealed in the literature review in chapter 2, the factors impacting a university-business coupled processes of open innovation network is complex. Few studies have attempted to analyse the functioning of this form of network, this project focuses on providing the relational context impacting (or contributing) to the process of innovation, learning, and

value creation. There are three empirical studies in this thesis that aims to understand different aspects of a functioning network. While diverse in objectives, the data collected and analysis techniques complement each other across studies. This section aims to illustrate the various analysis techniques employed within this project.

3.9.2 Thematic Analysis

A thematic analysis was conducted to aid in the identification of prevalent themes. Thematic analysis (Miles & Huberman, 1994) is used to examine the qualitative data generated from the exploratory phase of the study. This enabled new patterns to be discovered (Yin, 1994), and to identify and make sense of the relational activities and mechanisms taking place between different stakeholder groups (Faria & Wensley, 2002). This also enabled a more careful exploration of the interaction between the evidence and existing theory to emerge (Strauss & Corbin, 1990; Hughes & Perrons, 2011). Throughout the data collection and the iterative process of identifying themes continued until there was a level theoretical saturation and fresh insights could no longer be yielded (Yin, 1994).

The early phases of focused on the “continual comparison between the actors and their subunits based on the theoretical similarities and differences” (Gephart, 2004: 459). The research utilized multiple points for qualitative data collection, such as semi-structured interviews, participant observations of monthly technical meetings, field notes collected at regular board meetings, relationship themed presentations and informal networking events. This allowed for the convergence of the variables of interest and relied on converging multiple sources of evidence. The benefits of using this approach in the early stages is the development theoretical propositions that further guide the data collection exercises (Yin, 1994: 13). This allowed for new theoretical concepts to emerge from the field and allowed the researcher to modify and broaden the initial categories through iterative and constant comparison technique (Silverman, 2015). The early stages of the research project focused immersing the researcher in qualitative data collection to allow for the rich contextual details to emerge that extend beyond the theory. It is the belief that is adopted by many qualitative researchers who seek to illustrate the contextual details of an investigation during the inductive phase and that would otherwise be overlooked utilizing objective (e.g quantitative) methods alone.

These themes allowed the researcher to identify the prevalence of the compositional characteristics, the size of the network, idiosyncratic pockets and subgroups that exist within the network. Also, this analysis aided in identifying the differing relational contexts in which actors interacted with each other, and therefore provided the basis for understanding the

complexity of the relational linkages that characterise this network. The content of the relational ties varies between role identification and actors. Content goals is likely to affect the type of relational ties that hold the group. This analysis informed findings from Chapters 4, 5, and 6.

3.9.3 Chronology Analysis

A chronology was developed to aid in the analysis of the episodes of network evolution that have occurred since the origination of the relationship, taken on a longitudinal lens. In allowing for fairness and range, all data was compiled and drafted into a historical development and timeline section (Silverman, 1993). A common theme to understanding the inner working of this relationship was that the scale had grown organically and “*in a more fragmented way.*” This chronology revealed several events over time and identified four significant tipping points utilizing archival documents and participants accounts to provide a longitudinal lens through a time series analysis. Participant observations and field notes were also collected over a period of three years. There were key points when the network responded to internal and external pressures. This form of analysis aided in identifying patterns that reflected a level of stabilization as well as the development and adaptation/coordination through significant events within the timeline. This historical recount of the relational development was contrasted with Cross & Parker’s (2004) network evolution. It aims to reveal the co-evolution to in which the relationship was built (Robins, 2015) and the endogenous processes that contribute to network sustainability (Wasserman & Robins, 2012). The results will be presented in chapter 4.

3.9.4 Actor Level Ego Centric

The individuals or entities within a network are defined as actors or nodes. The focus of network studies is on the relationships held between each actor with other actors within the social system. This approach places an emphasis on the influence and diffusion of resources accessible to individuals in the network (Prell, 2011). While the emphasis of this form of analysis is on the relational linkages, individuals possess certain characteristics (or resources) and can characterise the opportunities (or constraints) that has the potential to become available. Therefore, it is common for researchers to gather a collection of demographic and compositional elements.

The ego-centric approach is another technique used by researcher to design, collect and analyse network data. Much of the literature employing social network data approaches utilizes an ego-centric approach to analysis (Kadushin 2012). This approach is like standard social science techniques in that it focuses on collecting data from an individual actor’s position to

reveal their own position within the network. The researchers may pursue the utilization snowball methods to define the boundaries of a social structure and the characteristics of the actors that lie within a specific social phenomenon (Hanneman & Riddle, 2005). This method adopts an exploratory stance to further explain specific streams of the much broader field.

There are limitations to employing this ego-centric approach in isolation. For instance, it is widely accepted that individuals are not always effective or accurate in reporting their extent of their relationships. Informant accuracy compromises the reliability of SNA data (Wasserman & Faust, 1994) due to studies that reflect that people are ineffective in reporting their interactions (Bernard & Killworth, 1977). Ego-centric data frequently requires the actor to simply state the people that they have specific relational ties through interviews or through the usage of name generators. This technique may also complicate the drawing of boundaries for the entire network as it may be difficult to conceptualize all actors (Hanneman & Riddle, 2005) or the prevalence of important yet latent ties (Marritotti & Delbridge, 2012). The data collection process may reveal complicated data sets if the size of the network under investigation includes multiple relational types or the actors reveal only a limited number of ties.

The ego-centric approach may be most useful when triangulated among the other approaches to collecting network data. This study will utilize the ego-centric approach to data collection following the collection of all names affiliated with direct interactions with the network on either side of the relational dyad. The ego-centric approach will also be utilized to determine the compositional elements of the network, such as human capital and the intensity of specific relational ties through the collection of electronic survey data (Dillman, 2000). This analysis began from an ego-centric approach, which employed a snowballing technique to identify further members and sources of data. The analysis then shifted to a review of archival documents to identify further members of the collaboration. Finally, a cross-sectional survey was distributed. This survey included a rooster design of all documented individuals within the network. However, it also included a name generator that allowed the participant to identify significant contributors to their project. Several names that emerged from the data collection existed outside the boundaries of the immediate network. This form of analysis has been used to inform the findings in all of the empirical investigation chapters.

3.9.4.1 Demographic Attributes

There were several demographic attributes that were collected on the actors in this network. The aim of this activity was to understand the composition of resources available

within the network by categorizing demographic attributes, as well as indicators of intellectual and relational capital.

Figure 10 - Actor Attributes (Demographic)

Attribute	Description
Knowledge Content	Area of Expertise University-Business Prior Experience
Subgroups	Departments Organization
Relationship Tenure	Strong or Weak Tie
Professional Status	Career Level
University-Business Experience	Years
Demographic	Age Gender
Projects	Volume Date of commencement

3.9.4.2 Behavioural Attributes

Several behavioural attributes were collected as well. For instance, time commitment and individual trust development (Tsai & Ghoshal, 1998). Questions were centered on the reliability of partners, the belief that shared goals exist, and the belief that promises were being kept. The belief of project success and that the individual was operating effectively. These measures were based on Aijzen & Fishbein's (1991) theory of planned behaviour, which was adapted to determine about the behavioural intent to remain involved in the network. There was also an assessment that was aimed to understand the frequency of new knowledge generation and whether the volume of learning experiences was satisfactory for the individual. Social capital and intra-organizational network development behaviours to promote knowledge access (Ferris et al., 2005; Ng & Feldman, 2010), knowledge sharing and collecting (Lin, 2007) and the extent to which members introduce external social capital.

3.9.4.3 Types of Relational Ties

The relational ties are conduits in which knowledge resources might be able to diffuse among the actors. Semi-structured interviews revealed several personal (friendship) relationships existed within the network. Chapter 6 presents the relational linkages that were strategically through contractual interdependence. However, the impact of previously collected evidence suggests significant deficiencies in reporting the density and cohesiveness of the network structure. This chapter also discusses the impact of informal linkages that are driven by behavioural factors rather than economic incentives.

3.9.4.4 Network Size

An understanding of the general size of the overarching network was obtained in the early stages of the project. However, self-reported conceptions over the size of the network varied per individual actor. Additionally, by analysing the semi-structured interviews and participant observations evidence of informal (and undocumented) links were providing resources to the network.

3.9.4.5 External Influences and Network Development Behaviour

This attribute aimed to understand the extent to which the individuals in the network engage with other forms of expertise to enhance their knowledge capabilities outside of the focal network. It also aimed to collect the individual's motivation to encourage new membership to the network. This attribute was aimed to understand the frequency of new knowledge generation and whether the volume of learning experiences was satisfactory for the individual.

Some researchers might seek to characterise the prevalence and influence of external members onto a particular network structure and how they access the resource in 'external economies' (Hoover and Vernon, 1962). Approaching SNA in this method looks toward an open system approach (Kadushin, 2011). These explorations of the external linkages may include a vast number of actors and complicated boundary specifications. For instance, research by Bernard and Killworth (2006) indicated that some individuals may have the cognitive capacity to manage approximately 280 interpersonal connections. This work also reveals that there is a large standard deviation within the populations of their study. Although they have been successful in gathering data, specifically from online networks, in other contexts the collection of data utilizing this technique is likely to require significant resources and research access may prove to be a challenge.

This study will acknowledge the open systems approach to illustrate the demands and potential transfer of social capital to actors on the external fringes of the network structure and how the interplay of authority, legitimacy, and leadership effects the actors internal to the relationship (Kadushin, 2012). An open systems approach may illustrate the extent to which weak ties and external novel resources characterise the 'access' the network has through a less bounded view (Jarillo, 1994; Cross & Parker, 2004), but can lack the density necessary to reveal multiple levels of relational channels and behaviours.

3.9.4.6 Learning Frequency and Knowledge Goals

This attribute was aimed to understand the frequency of new knowledge generation and whether the volume of learning experiences was satisfactory for the individual. This attribute was collected to understand the underlying motives for new knowledge generation. This attribute was collected to understand how value is assessed within this network. Early analysis revealed that the patents and publications generated were not the only valuable learning outcome achieved within this network. This study developed measures that requested information on the volume learning experiences to assess the vitality of the knowledge exchange between organizations.

3.9.5 Whole Network (Structural)

A final method analysing a social network is by adopting the whole network approach to characterise the interactions within a pre-determined boundary or within the phenomena of interest. The benefits of this level of analysis is that it approaches the data from a top down perspective to view the relational patterns within the entirety of a network structure (Hanneman and Riddle, 2005; Galaskiewicz and Wasserman, 1994). The level of detail that can be derived is a step forward in the robustness of characterising a social structure (Wasserman and Faust, 1994). This allows the researcher to measure specific patterns and pinpoint areas of interest.

However, utilizing a whole network approach may also induce limitations. Some researchers have attempted to analyse full network data, however these studies have approached network data from a primarily macro level view and have overlooked the potential for compositional elements, which exist within the micro-level processes within the network, to influence the patterns emerging in the analysis. Also, resource access and collecting whole network data can be very time consuming and costly (Wasserman and Faust, 1994). However, the social network approach can be employed to emphasize the duality of the individual and the social structure that they lie within, and thus there are multiple levels of analysis (Wasserman and Faust, 1994).

3.9.5.1 Network Boundaries

This analysis aided in the development of understanding the extent of the boundary conditions for the network structure. Most networks are not completely bounded within the confines of a single social structure and an entire network of activity can prove to include a vast number of actors (Bernard and Killworth, 2006). These limitations appear to be largely influenced to the data access issues the researchers may have faced and the sheer complexity of analysis (Braun, 2005; Kadushin, 2011). The extent of the network activity extends beyond

this direct network structure and begins to blur the boundary lines insomuch that researchers may face difficulties during an attempt to draw the boundary specification. Because of these challenges, networking theorists might apply varying methods in the ways that they define the boundaries of the network (Wasserman & Faust, 1994; Cross & Parker, 2004; Kadushin, 201; Carrington & Scott, 2012). This section will briefly introduce the approaches that network theorist commonly applies to their studies.

Social network studies often face conceptual issues in determining the boundaries of the analysis. The primary focus of this study is on the relational dyad that has been built between these two organizations, however there are issues in empirical examinations as the influence of social systems external to the dyad impact the internal activities. Chapter 6 presents an overview and analysis of the different forms of networks impacting this relationship and their potential to impact performance. The analysis of the various networks impacting university-business collaborations is presented in Chapter 5, and aided in the development of the boundary condition used in chapter 6.

3.9.5.2 Socio Gram and Matrix

This analysis has focused on the creation of a single variant, non-directional socio-graph of contractual linkages between actors (simplex). This reveals an extent of centrality, prestige, and position of the actors within the idiosyncratic pockets within the collaboration (Wasserman and Faust, 1994). Additionally, a socio-matrix of non-directional dichotomous relations of non-ordered pairs to was drafted to reflect the task interdependence of these contractual relations. It is proposed that this relationship is further characterised by multi-relational ties and compositional elements will further aid in characterizing informal linkages and promotes cohesiveness. Binary measures of relations. Coded 0 for absent and 1 for present. Please see below socio-matrix.

	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10	n11	n12	n13	n14	n15	n16	n17	n18	n19	n20	n21	n22	n23	n24	n25	n26	n27	n28	n29	n30	n31	n32	n33	n34	n35	n36	n37	n38	n39
n1		1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
n2	1		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
n3	1	0		1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
n4	0	0	1		1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
n5	1	0	1	1		1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
n6	0	0	1	1	1		1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
n7	0	0	1	1	1	1		0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n8	0	0	1	0	0	1	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
n9	0	0	1	0	0	0	1	0		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n10	0	0	0	0	0	0	1	0	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n11	1	1	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n12	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n13	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n14	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n15	0	0	0	0	0	0	1	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n17	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n18	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n19	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1		0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
n21	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0		1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	
n22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	0	0	0	1	1	1	0	0
n25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0	0	0	0	0	0
n26	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
n27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1	1	1	1	1	1	0	0	0	1	
n28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		1	1	0	0	0	0	0	0	0	
n29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1		1	0	0	0	0	0	0	0	
n30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1		0	0	0	0	0	0	0	
n31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0		0	0	0	0	0	0	1
n32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		1	0	0	0	0	0
n33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1	0	0	0	0	0
n34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1	0	0	0	0
n35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1	0	0	0
n36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
n37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
n38	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
n39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

3.9.5.3 Roster Survey Design

A roster design survey was developed to collect additional data on the connections and reciprocation with the science and administrative network.

3.9.6 Overview of Empirical Chapters

Each empirical chapter adopts a different analysis technique. This section provides a brief overview of the analysis. A more detailed discussion and description of the analysis techniques and data utilized will be presented along the analysis chapter it is coordinated with. The final stage of the project aims to illustrate the contributions of the informal relational linkages to the network's functioning. This thesis aims to illustrate how what aspects of formal and informal network components facilitate collaborative behavior, insomuch that its prevalence results in value creation, innovation, network growth, and sustained results.

The first empirical chapter analysis focused on identifying the themes that emerged from all pieces of the data. This exercise was followed by drafting a detailed chronology based on the archival documents, observational techniques, and the interview data. It will first be presented and evaluated to examine specific aspects of governance and coordination between

the university and the business. The first study within this project focuses on revealing the dynamic and self-organizing processes in which the relationship was built. A chronology and thematic analysis of archival documents, interviews, and participant observations.

The second empirical chapter focuses on clarifying a common conceptual problem that occurs within studies of open innovation, inter-organizational partnerships, and university-business relationships. Studies of networks often select members within a particular relational dyad as the focal point for investigation. However, the boundaries and influence of network activities is likely to make considerable impacts on the observations. Research using network approaches could enhance the development of the field if they explicitly define the characteristics of the boundaries selected and the other options.

The third empirical chapter has an analysis for this data set focuses on ‘quantifying the qualitative’ through the creation of socio-grams and matrices to represent the data in line with the social network analysis techniques. The qualitative data collection exercise provided the opportunity for an objective display of the formal organization and task interdependence. This will then present early observations about network content and behaviours are presented and has implications for the conceptual development for the final data collection exercise and analysis. The analysis focused on the creation of socio-gram, which focuses on the centrality, prestige, and position of the actors within idiosyncratic pockets within the collaboration, and a socio-matrix of non-directional dichotomous relations of non-ordered pairs to show task interdependence. This empirical chapter also brings data from a cross-sectional survey that was aimed to collect and analyse aspects of the collaboration as perceived by actors within Durham University and P&G, which provide a richer understanding of the dynamic interactions between the formal organization and informal coordination, which has implications for strategic innovation and network management. The analysis was based on qualitative observations and a cross-sectional survey. The informants were the entire population of individuals at Durham University and P&G involved in the relationship in any way, however the cross-sectional did not achieve a response high enough to reliably present the network data. The respondents were asked to self-report linkages through a roaster cross sectional survey. While the rooster survey had not produced the anticipated response rate, it also collected useful insights on knowledge goals and views of value creation, that are referred to in chapter 6. The survey also collected node compositional elements, such as ego-centric perceptions of network and knowledge sharing behavior.

CHAPTER 4 NETWORK EVOLUTION AND ADAPTIVE PROCESSES IN UNIVERSITY-BUSINESS RELATIONSHIPS

4.1 Chapter Introduction

This chapter addresses the need for research to be conducted on the development of social capital behaviors in inter-organizational relationships, particularly within the context of university-business coupled processes of open innovation. The university-business context provides a compelling backdrop for understanding this form of relational exchange and is interesting to study for many reasons. From an open innovation perspective, there are few studies that approach university-business relationships utilizing a network approach to understand the relational context that contributes to knowledge generation, and there are many projects that place a large emphasis within the open innovation literature that contractual elements govern university-business relationships. For the most part, the potential for the coupled process to occur within this relational exchange has been overlooked. Much can be learned about the nature of this collaboration through utilizing a network dynamics and inter-organizational approach to the investigation.

4.2 Chapter Data Collection and Analysis Technique

This chapter takes the form of a holistic case study (Yin 1994; Silverman, 2014). The benefits of this research design in the early stages is that it allowed for flexibility so that potentially novel discoveries and variables emerge due to the less stringent methodological requirements (Yin, 1994) and has adopted an exploratory stance that was aimed at deriving the contextual details of the relational channels and the various attributes of the actors embedded within the network structure (Wasserman and Faust, 1994). The relationship studied began in 2011, and continues to function and create value to this day. The primary data collection for this project initiated in October 2013, and continued through April 2016. The primary data consisted of fifteen participant observation in the executive board meetings, fourteen direct observations of joint problem and technology transfer sessions between corporate R&D and university scientists, fifteen semi-structured interviews, and five informal interactions. Additionally, this chapter includes the analysis of the archival documents that had been stored in the relational database since the first interactions between the university and the business.

All field notes and interviews were transcribed and saved in an electronic format. All documents and information from the collection exercises was compiled into an electronic database. This included all corresponding documents, transcriptions, and other forms data

which was then summarized and sorted per theme. This database was developed within a 76 pages Microsoft Word table. This table allowed information to be tabularize per first and second level codes by themes to emerge as well as to account for the frequency of events. This allowed themes to be derived in an inductive way, rather than specifically aiming to match data to pre-existing theoretical lenses (Silverman, 2014). The date of the communication then sorted archival data. Also, key messages from the semi-structured interviews were aligned with corresponding time periods reported by the participants. Data was then interrupted based on the purpose of key activities, events, or forms of communication occurring within the documents.

A chronology was developed to aid in the analysis of the episodes of network evolution that have occurred since the origination of the relationship. In allowing for fairness and range, all data was compiled and drafted into a historical development, significant events and timeline section (Silverman, 1993). This analysis was complemented with thematic analysis. For the thematic analysis, the observed primary and secondary data was then reduced into a data base for identification of prevalent themes. This data consisted of the archival documents; communication documents, field notes, public press releases, public and private presentations, board meeting minutes, technology sharing documents, project pipeline documents, and project case studies. The data was then dated in chronological order and themes were identified in alignment. The objective was to identify the various underlying motivations and the focus of strategic concern at the point in time in the relational development. This chapter identified significant moments for the network, utilizing archival documents and participants accounts to provide a longitudinal lens through a time series analysis. This aided in identifying patterns that reflected a level of stabilization as well as the development and adaptation/coordination through significant events within the timeline.

This chapter presents the themes that most closely aligned with focuses in this network's development over time. The chapter begins by discussing pre-network engagement and the onset of early communication and identification of partner capabilities. This was a crucial moment for the potential development of the network and is discussed prior to presenting the themes associated with formal initiation. The section that follows presents the themes associated with each phase of development and the actions that stimulated a shift in strategic focus within the network. Figure 11 provides an overview of key events.

Figure 11 - Chronology of Events

Date	Event
2009- 2010	Initial Discussions – Large Amounts of Corporate Members tours and having talks
July 5-6, 2010	Workshop – Corporate Germany, Brussels, US, UK attended and was held at Uni Chemistry, Biology, Physics, and Psychology.
June 2010	Project with Local Innovation Centre (First PROJECT)
July 2010	Studentship support committed for first project
August 2010	Technology Mapping Document/ Presentation sent to the HQ
December 10, 2010	Started working on the RGF bid with a due date of Mid-January 2011. (Had to move quickly)
2011	Conversations started about funding students from Chinese University – Students starting October 2014
February 2011	Found out that the RGF had been awarded
June 2011	RGF Contract was awarded – Recruiting started
July 5, 2011	Meeting was held after they found out the Regional Growth Fund was awarded. Workshop with 4 P&G people addressed the entire department on the sort of things that they were interested in.
October 2011	Large Scale Project Kicked Off –Took two years to recruit
November 2011	New (and existing key Corporate member) became involved
October 2012	BBSRC Grant and Biology Work Started
December 2012	Marie Curie EID – Application went in. Since Uni is in the UK, the industry had to be elsewhere. 50 Uni/ 50 Industry. Looked at Corporate Europe Locations.
December 2012	Corporate Internal Meeting held at Uni – Not a University event
April 30- 2013	Letter to Corporate Leader regarding the development of the relationship
July 3, 2013	Letter of Intent – 5 year investment
September 2013	Marie Curie Funding was awarded.– Lots of reports to be done.
September 3, 2013	First Board Meeting

November 2013	Spin Out - IPO - £77 million in the first week (External Partner)
November 8, 2013	Second board meeting
November 12, 2013	Science Event hosted by Corporate Toured the Microscopy Lab
November 26, 2013	Director Presentation for new departmental member
December 10, 2013	Technology Workshop
January 14, 2014	Third Board Meeting
January 15, 2014	University Strategic Partner Meeting
February 4-5, 2014	Tech Workshop
February 26, 2014	Fourth Board Meeting
February 2014	Innovation Conference– Presented relationship
March 11 2014	Cycle Fund Reports due from Head of Departments, and Director and Technical Lead
March 25, 2014	Seventh Board Meeting
March 2014	Meeting with Strategic Partner in China
May 2, 2014	Board Meeting
May 12, 2014	Meeting with University Partners for Joint Program
May 24 2014	CTO Match Funding Contract Deadline Date
May 30, 2014	Workshop
June 17, 2014	Board Meeting
June 19, 2014	Consortium Partner Meeting
June 26, 2014	Consortium Partner Meeting
July 10, 2014	Review of high risk projects
September 17, 2014	Board Meeting
October 2014	Marie Curie Started
October 20-22, 2014	Symposium
October 22, 2015	Annual Report Due
January 15, 2015	Board Meeting
February, 2015	CTO visits University – Positive feedback
March, 2015	Advertisements for Short Term Student Placements Begin

March 2015	Change of Procedure for Confidentiality
April 13, 2015	Board Meeting
April, 2015	Deadline for Consortium Grant
May 2015	Royal Society Teamwork in Innovation Award
June 29, 2015	Board Meeting
October 7, 2015	Board Meeting
Januray 18, 2016	Board Meeting
April 25, 2016	IP Workshop
June 15, 2016	Board Meeting

4.3 Early Alignment and the Pre-Existing Platforms to Exchange

As mentioned previously, there has been little attention has been given to the dynamic governance issues that surround the alignment of a university and a business. For example, Chesbrough (2003) illustrates the potential for university and business collaboration in the context of an ‘open innovation business model’, but only briefly mentions the need to develop a relationship through a series of contractual agreements. Others have acknowledged the extent to which these diverse partners might encounter challenges in alignment, but have focused on the necessary usage of intermediaries (Huizingh, 2012; Wilson Report, 2012). Many scholars contend that the success or failure of strategic relationships is dependent on the existing similarities between the organizations. Research supports that there is a level of uncertainty avoidance in strategy development with external partners and the impact of cultural variations between organizations, emphasizing the importance of alignment and the relational development behaviors (Barr & Glynn, 2004). Whilst assessing economic objectives is an essential aspect of alignment, yet it is an incomplete analysis when conducted in isolation (Larson, 1992); as is apparent within the complexities faced by the current state of university and business relational contexts. A significant factor impacting this alignment, especially within the university-business relational context, lies within the different forms of open innovation based on the objectives and resource needs of the organizations; e.g. inbound, outbound or coupled (Gassman, Enkel, & Chesbrough, 2010). The knowledge resource deficiencies (or surplus) of a focal firm determine the format of the approach taken. However, the potential for collaborative innovation has been discussed very little in the literature.

There are variances in anticipated knowledge generation and research objectives suggest that there are significant risks for complexities in the alignment of organizational

cultures and management practices; e.g opportunity identification, definition, creation, coordination, and outcomes (Kogut & Zander, 1994). Fostering knowledge sharing has been associated with the organizational climate (Brock et al., 1994) that promotes acceptance and acclimation of innovation (Myer & Goes, 1988) and knowledge combination capability within inter-organizational networks that relies upon relational capabilities (Carmeli & Azerouli, 2009) and appropriate responses to various external factors.

By working together, actions driven by common instead of competitive interests can serve to improve conditions across several stakeholders involved in the relationship (Hughes & Perrons, 2011), but the organisation must then generate trust within the set of relationships it holds with another actor or set of actors for this to happen. Which emphasizes the role of relationships and trust as a governance mechanism that improves performance (Zaheer & Venkatraman, 1995; (Zaheer et al., 1998). It proposes that members of university and business relationships have the potential to operate as separate entities and a long-term basis through careful alignment of resources and contributing their individual areas expertise without necessitating integration or point of redundancy. For instance, a corporation might possess intimate market knowledge that aids in the exploitation process of new technologies while a university possess superior capabilities in the exploration process (March, 1991). The potential for benefits to emerge from resource sharing among partners is impacted by a variety of organizational factors, the strategic intentions of both firms, and how the relationships are managed (Gupta & Govindarajan, 1986; Tsai, 2001).

4.3.1 Organizational Capabilities: The P&G Context

Procter & Gamble is multi-national consumer goods company headquartered in Cincinnati, Ohio, USA. The company originated in 1837 in a partnership between candle-maker, William Procter, and soap-maker, James Gamble, and boasts a long history of innovation and adaptation. In 1930, P&G expanded into international markets through the acquisition of Thomas Hedley Co. in Newcastle upon Tyne, UK. This acquisition allowed the company to diversify into Tide and Crest brands. Current operations span into 80 countries in matrix structure with innovation centres located in Brussels, Italy, China, Germany, US, Singapore, and the UK. Today, they have 26 billion dollar brands, a product portfolio mix that touches 4.6 billion consumers daily, and global brand recognition. Global business units are aggregated in to five reportable segments, fabric and homecare, beauty, baby and family care, healthcare and grooming. Each of these different business units are responsible for local market knowledge and innovation plans for the brands (Marketline, 2013) The annual investment size

of \$2 billion dollars into R&D, as well as another \$400 million into fundamental consumer understanding.

Like many other businesses, the turn of the millennium presented the company with challenges, such as stagnant growth, and lack of internal innovation showed. Product launch success staggered at 35% and R&D costs exceeded 5%. Only 15% of the initiatives were successful (Brown & Anderson, 2010). The innovation portfolio was not delivering enough to make the growth goals of the company. The company needed a new philosophy to rejuvenate the expectations of their investors and to retain their competitive edge, as Wall Street commands a \$4-5 billion in incremental /organic sales growth each year. They needed to identify ways to increase the size of success, as stagnant growth was causing the stock to decline and there was a loss of investor confidence.

4.3.1.1 Connect + Develop

At the turn of the millennium, and under the leadership of A. G. Lafley, the company refocused their R&D philosophy to an open innovation business model, Connect and Develop (C+D) to acknowledge the potential efficiency gains that might be achieved by accessing externally held knowledge stocks. This new model acknowledges the potential for growth through assimilating external ideas and tapping into the knowledge economy. This move was celebrated by business scholars and inspired, with Chesbrough (2003) pioneering the research and developing the field of open innovation. The logic behind this was that the R&D costs soared, they had considerable success with external and previous partners and an open innovation philosophy looked promising to delivering more efficient. Lafley set an ambitious target of sourcing 50% of innovations from beyond the walls of the business. Also, an aggressive M&A which focused on high growth areas for investment and the reduction of manpower through. They employ a variety of formats that they are crowd sourcing and developing strategic partners. For P&G, open innovation means a systematic approach to collaborating with the external world for ideas. They acknowledge that the prevalence of the knowledge economy. For each one of their 8,000 R&D scientists there 200 that each one can collaborate with. It's about leveraging internal capabilities.

Although this philosophy was highly lauded by scholars and practitioners, by 2006 this innovation model stopped delivering 'blockbusters' and most growth was attributed to line extensions and acquisitions. External pressures, such as consumer price sensitivities and the activities of rivals, resulted in the loss market share in 2/3 of its markets and loss of confidence among investors and employees. Only 2% of the crowd sourcing were proving to deliver value

and required a lot internal resources to sort. The company realised that they were approaching innovation from a reactive position. They were also overwhelmed with a large volume of unsolicited inquiries through their open innovation philosophy. The one-off deals were too small for such a big company. The company needed a method to ensure steady incremental improvements to generating growth in the short term, while planning for the uncertain future. Short term goals were designed for quick wins but they needed a way to focus on the future.

The leadership changed hands to Bob MacDonald in 2009, and the company faced a period driven by intense control mechanisms and efforts to standardise. There was development in rigid processes and handbooks that had the potential to undermine their innovation prowess. In 2013, activist investor called for leadership change after faltering performance and slow growth. That year MacDonald resigned and Lafley was placed at the helm again. In August 2014, the company announced that it will be cutting 100 brands to focus on 80 high growth products that represent 95% of the company's profits and to realign their strategic fit (Cincinnati News, 2014).

4.3.1.2 P&G's Systematic Approach to Innovation Processes

While P&G recognize the value of openness in the innovation process, the size of the organization requires some formal mechanisms to ensure that innovation is achieved in a systematic and strategic way. P&G's growth factory is one of the methods in which they systemize this process. The growth factory dash board provides common and well understood data displays to senior managers across the globe. It aims to reduce the amount of time focused on how to display the data correctly across the various organizational units, and to what extent are the various categories performing well in terms of consumer acceptance. Rather than focusing on the complexities of analysing growth patterns and trends it allows the decision makers to spend more time devising ways to address issues with stagnant growth and problems, it frees time for creativity to emerge. (Davneport, 2013).

The internal R&D process develops projects through collecting the support of an idea. The project is then funded through the 'idea' being internally promoted and supported to the various business units. The idea will receive internal support if the project has the potential to address challenges defined within the departmental objectives. However, once a project is defined it is the PI's responsibility to find internal and external partners. This specified business model and provides a budget allowance for uncertain science. During the recession, the focus of most R&D departments was on the incremental/safe and immediate innovations that would result in profit now. However, P&G recognized that it needed a long-term focus. The R&D

scientists define technological challenges that have the potential to provide the business with substantial benefit if those particularly uncertain challenges were solved. This provided the impetus to receive seed corn funding for the uncertain science.

Every technical scientist has five long term goals that they are working on. These long-term goals are often backed by extensive consumer research and hard financials that allow the company to calculate ‘the size of the prize’ if they are to solve these technical challenges. However, some projects offer the opportunity to solve unique or challenging issues. Whenever a new project forms each internal PI is required to consider a university partner as part of the procedure for ‘research proposals. As reported by a participant to this study: *The answer doesn’t have to be that they will use a university partner, but it is part of the standard process to consider them.* Through allowing universities to focus on the fundamental sciences, the internal R&D person can focus on the internal/incremental needs that are more certain.

4.3.1.3 P&G’s Connections with Universities

Historically, P&G has worked with over 200 universities & research institutes, on several hundred projects. However, almost 70% of university collaborations have been “*one shot deals*” and most work has been characterized as opportunistic and tactical. Connecting with universities has always surrounded the fundamental knowledge science. However, the academic landscape is different across the globe. There are also different approaches to ‘knowledge ownership’ and often new collaboration require lengthy negotiation process to initiate a project. For instance, several interview participants discussed the difference between the US and the UK approaches to this negotiation process. In the US, the underlying philosophy is that if the University creates the technology they own the licensing rights to access, it doesn’t matter who commissioned the research. After the research has been completed, the company still needs to pay for license to access the IP. This exploitation expectation makes finding partners in the US more difficult at the broader University level. These negotiations must be done on the individual level and has implications for the potential to scale a collaborative effort.

When asked about the differences between the US and the UK philosophies one participant replied:

One of the things that struck me is the desire to collaborate and to collaborate on very applied science. So, that was the very first thing. In North America, I would say that we are very big, very big country with lots of diverse ways of operating and very diverse opinions about what universities should be about. Whether they should be about applying the science for commercializing technology or whether they should be all about the fundamental understanding of the science.

The ability to capitalize on the UK government innovation initiatives helped to de-risk the investment into these areas of uncertain outcomes, as well. The underlying cultural receptiveness to industrial linkages and the institutional facilitation of research conducted in the UK is also different. There are more flexible approaches to IP ownership issues.

4.3.2 University Capabilities: The Durham University Context

Durham University (DU) is a public, collegiate, and research Higher Education institution situated in the Northeast of England. It was granted royal charter in 1837 and has a distinguished global reputation, with Time Higher Education and QS World Rankings consecutively recognizing the institution among the top 100 universities globally. The annual turnover is approximately £65 million and has about 16,000 students. The university is generally ranked in the top 3 UK Universities for Physics, Chemistry, General Engineering and Mathematics, and Geography. Also, it is ranked in the top 5 for Biological Sciences, Mathematics, and Geography. Additionally, Durham University is one of three collegiate universities in the United Kingdom. It consistently ranked among the highest in the country for student satisfaction due to the high levels of student support offered. It attracts students from all over the globe.

The university is divided into three different faculties, Social Science & Health, Arts & Humanities, and Science, with twenty-four different departmental disciplines. However, there are eight cross cutting institutes which provide a platform for multi-discipline collaboration on complex issues. These include the Biophysical Sciences Institute, Durham Energy Institute, Wolfson Research Institute, Institute of Hazard, Risk, and Resilience, Institute of Advanced Study and others.

4.3.2.1 Durham's Motivation to 'Open'

For Durham, improving relationships with industrial partners extends beyond securing innovative funding sources but also to contribute to the HEFCE intentions of enhancing research objectives that has the potential for societal impact, which can thus enhance competitive positions and quality rankings. In 2014, one of the interview participants stated that one of the strategic objectives that the University is focusing on the

The over-arching aim of business engagement activity is to enhance the quality of research and to further develop the research impact (whilst) building long-term mutually beneficial (...) partnerships...

As part of the university's strategic plan 2010-2020, it has emphasised an importance for sustainable operations and less financial dependence on national funding through the development of partnerships. In 2010, the Department of Business and Innovation Services was developed at the university to aid in fostering newly developed technologies into innovations and engage with commercial activities for the university and businesses. Like many technology transfer offices, this department handles the management of spin out activities, inventor ship clauses/intellectual property licencing, incubator services, commercial research collaborations, etc.

4.3.2.2 Evidence of Innovation Capabilities: Spin Outs

The capability to create commercial viable products lies at the heart of innovation challenges of many organizations (Slater, Mohr, & Sengupta 2013). Relative to other forms of innovation, radical product innovations offer unprecedented customer benefits, substantial cost reductions, or the ability to create new businesses. Radical innovation is a dynamic capability. Soh and Submarian (2013) results show that technological recombination focus strengthens the relationship between university collaborations and patent performance, whereas scientific research focus weakens the relationship. These results also differ between young and old firms, implying that firms may shift their R&D focus per their collaborative objectives. Because radical product innovations face an inherently more uncertain development process, more complex customer adoption process and, by extension, a more difficult marketing process, radical product innovation requires a different skill set for a firm than does incremental product innovation (Leifer et al., 2000).

Durham possesses a capability to produce commercially viable technologies (stated differently: radical innovation capabilities) that were relevant to P&G's interests was evident in their spin out history. Research by O'Shea et al. (2005) utilized econometric factors to determine what facets contribute to some universities spin out capabilities. They found that faculty quality, size, and commercial capabilities positively predict a universities capability to produce viable spin outs. The reputation and spin out history was relevant to P&G's needs, in fact, some of these spin outs were partners in the early projects. These spin outs as a knowledge transfer mechanism. For example, Durham Graphene, Ltd., which was subsequently named Graphene, Ltd., went through the IPO process in November of 2013. This company's valuation was £77 million within the first week. This company continues to retain a close with the University. Additionally, two other DU spin outs also remain in close contact University through similar collaboration projects for this relationship, Re-innervate and Surface

Innovations (sold to P2i). An additional example is the spin out company called Kormek. In 2009, its founder, Durham Alumni, was named Ernst and Young's "Young Entrepreneur of the Year." It was sold in 2010 to California based Nova R&D. At the time of sale, this company was valued at \$80 million. However, there are several other examples of successful prior innovations that increased P&G's confidence in their abilities.

4.3.3 First Interactions

There are several factors that lead to the increased interest to engage within this type of relationships for both partners. For instance, economic turbulence in developed countries has strained the public resources for scientific research which has encouraged academic institutions to become more independent in securing the finances necessary to sustain research activity and breadth. However, the UK government frequently assists through hosting networking events.

P&G had a desire to deepen its open innovation programme by accessing knowledge held within universities. The relationship began in 2010 in response to the increased pressure on universities to engage with industrial partners. Interview participants recalled that initial discussion was held at one of these events. In an informal conversation, both organisations had expressed that they experienced a common dissatisfaction in establishing an efficient model for sustainable collaboration within this relationship. This starting point set out common ground between P&G and DU that enabled an initial relationship to form. From a social psychology point of view, this formed a basis for a shared language and shared expectations. The pressures of external environment for both parties also indicated a sense that each are underwent a need for a shift in strategy.

There was also a unique alignment between the partners from the outset. While the credentials provided evidence of their capabilities, they also displayed a capability to joint problem solve. In fact, an interview participant indicated that a selection of prior relationships have not developed in a fashion and did not provide equivalent benefits, they stated "*one size does not fit all.*" During the first board meeting, it was stated that "*P&G is trying to change direction – the objective being to turn intent into reality – to turn investments into project proposals and looking to establish major programmes to invest.*" Each partner has a wide variety of partner to select from, yet where other relationships have remained stagnant in terms of growth and collaboration, this relationship continues to deliver value and satisfaction. An interview participant from P&G indicated that, "*When we scouted the whole academic ecosystem in the UK, Durham quickly rose to the top. Both as having lots of things that we were*

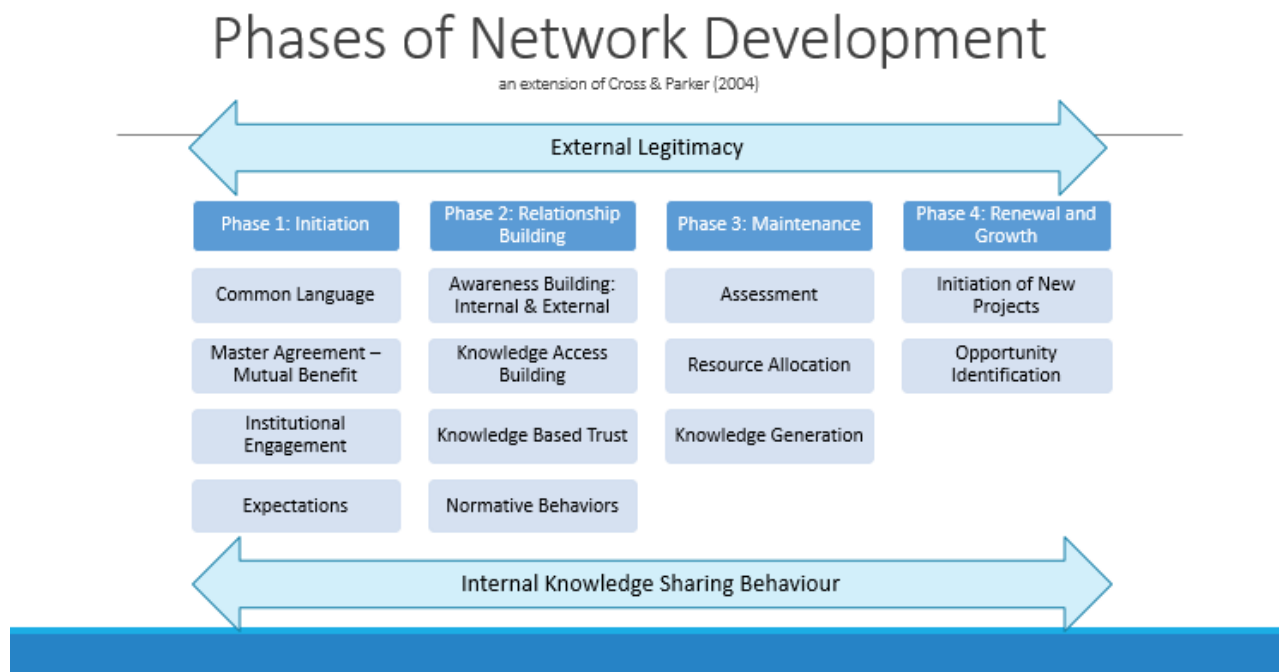
interested in, but also upon the very first interactions, an entity that we could really work with. And to be very blunt, some of the universities don't want to be bothered."

Evidence from this data collection and exercise reveals evidence of an atypical alignment for both partners. By working together, actions driven by common instead of competitive interests can serve to improve conditions across several stakeholders involved in the relationship (Hughes & Perrons, 2011), but the organisation must then generate trust within the set of relationships it holds with another actor or set of actors for this to happen. Which emphasizes the role of relationships and trust as a governance mechanism that improves performance (Zaheer & Venkatraman, 1995; (Zaheer et al., 1998). This early phase reflects the development of relational cognitions as well, such as reputation and evidence of capabilities provided the organization with the ability to overcome early apprehensions. The next section will discuss this relationship developed over time.

4.4 Network Development and Growth

This chapter will illustrate the specific episodes in the development of the network. Despite an implicit acceptance among existing studies that the social capital that is needed to unlock learning is behaviorally driven, there is a general absence of understanding into how firms go about the process of creating meaningful and trustworthy ties that build and bear social capital, or what effects such social capital development behaviors have on value creation thereafter (Granovetter, 1985; Ng & Feldman, 2010). The first section will illustrate the evolution of the relationship and give light to the multifaceted adaptive processes that have facilitated its functioning. This story is intriguing given that the initial stages that fostered growth were largely self-organized and approached organically. As the network matured, the need to establish legitimacy and formalization occurred in response to the need to stabilize and allow the potential for growth. The model utilized for this stage of the analysis has been adapted from Cross & Parker (2004), who identified the first three phases of (organizational) network structure within an organic team. However, it is apparent from the analysis that this relationship has had 4 major phases.

Figure 12 - Phases of Network Development (Extension of Cross & Parker, 2004)



4.4.1 Network Development Phase 1: Initiation

The initiation phase focused deeply on understanding each other's mutual needs as well as how to leverage capabilities and resources that each partner could bring to the table. For the university, this meant devoting diverse expertise, drawing external partners, and negotiating fair IP rights. For the business, this meant ensuring that academic goals were still capable of being achieved and bringing unique challenges to the table. This stage of the relationship was built purposefully; yet, it grew organically and was responsive to dynamic changes that required a shift in strategic focus. Once the project initiated, the processes which governed the relationship were adaptive, as there were not a formal planning procedures drafted at this this stage.

The story initiated with informal interactions between three key individuals. They met at a Government sponsored event that was designed to inform universities and business how to interact engage with one another.

4.4.1.1 Finding a Common Language for Knowledge Exchange

The external environment for both parties indicates a sense that each are undergoing a period of strategic renewal and their credentials provide evidence of their potential to provide opportunities to partners, however they have also indicated that a selection of prior relationships have not developed in a fashion that provide equivalent benefits and that “*one size does not fit all.*”

There was a common dissatisfaction between both partners in defining a business model that produced sustained results, and this provided the common language necessary to initiate discussion with key actors at the forefront. However, the initiation process was much more complex. The group needed to define the tools that were necessary to communicate the ‘how’ and the ‘why’ effort should be expended on development to a wider audience. Several factors contributed to this stage. Durham was identified as working on interesting science and things that were relevant to P&G. There are varying degrees of research objectives that exists between academia and industry, and Durham’s interest in the practical application of fundamental research and ‘real’ world applicability was attractive to P&G.

During a meeting with some of the participants, it was stated that *“P&G was trying to change direction – the objective being to turn intent into reality – to turn investments into project proposals and looking to establish major programmes to invest.”* Each partner has a wide variety of partner to select from, yet where other relationships have failed to meet the ‘scale’ of the vision each had, yet this relationship continues to grow.

An interview participant from P&G indicated that, *“When we scouted the whole academic eco-system in the UK, Durham quickly rose to the top. Both as having lots of things that we were interested in, but also upon the very first interactions, an entity that we could really work with. And to be very blunt, some of the universities don’t want to be bothered.”*

Another element of common ground between organisations lied within the geographic proximity of sites and the ability to engage in deeper resource sharing. This offered advantages for the relationship in terms of the ease to increase the depth and degree of interaction, allowing for higher frequency of interaction important for social capital to form. This ease and frequency of early interaction enabled a more comprehensive understanding of each other’s resources and capabilities to be learned. For example, an early interaction lead P&G to learn of the potential to access DU’s microscopy expertise, which has since enabled more efficient analytical processing for P&G’s regional Innovation Centre. Also, a brief conversation among technical experts from DU and P&G staff led to an immediate financial saving and resolution to a technical challenge faced by P&G. These events created powerful insight into the hidden value that could be unlocked through a formal relationship, if challenges surrounding its efficient management and coordination could be overcome. Several interviewees attributed the geographical proximity as a primary contributing factor to the development of the relationship. P&G’s Newcastle Innovation Centre is 22 miles from Durham University’s Science Site. One

of the stories about how the relationship began involves the UK formulation centre, which ran at Durham. P&G's Newcastle Innovation Centre was sending data back to the Cincinnati location to be analysed. During an early meeting, Durham's capability for this type of analysis was discussed. P&G began to think "*if we have been missing this trick, then we must be missing others.*"

These features fostered the dialogue necessary to establish the next stage in the network evolution. Fostering a common language has been associated with the act of forming in group membership (Taijfel, 1977). From this point, three levels of networks emerged within the relationship. These formed in fragmented and self-organising ways initially and became increasingly cohesive in time as transactional relationships grew, supporting the literature of the network form of inter-organizational relationship (Barringer & Harrison, 2005). The next three sub-sections detail each of these network levels and discuss the important mechanisms at each stage.

4.4.1.2 Master Agreement: Deterrence -Based Trust

The core challenge identified by the partners lied within the potential for conflicts about knowledge ownership and commercialization of developed technologies. Within that challenge, a further complication stemmed from the tendency among university and business relationships to have idiosyncratic contracts for each new project. The implication of this being that within any one relationship there may be many different legal contracts in place each accounting for a specific project. The need for contractual negotiations, mechanical governance, and project management complexity is inefficient and unattractive to grow an overall university-business relationship. To minimize the negotiation process, they simplified the governance of the overarching relationship and speed up project development and approval. The P&G and DU relationship established a 'master agreement' to govern the nature of knowledge ownership, intellectual property and technology commercialization on a scale that covers the university rather than any one individual. This governance approach is unusual and non-standard practice, but this allowed the relationship to grow and scale very quickly. For example, in the first year of the relationship alone, 7 number of projects were set up and over the course for the next 4 years, a further 55 projects were established.

Cited by many interview participants the IP arrangements have been commended as being unique and allows for an ease of coordination. However, another participant stated a different perspective:

I think the IP terms are a more practical issue. But, I think that a bigger one is the more heart of it is the cultural difference. It's where the academics place the importance of industrial science. It's very different in the UK than it is here. It's hugely different. American universities a long time ago now, got a bug in their bonnet about monetizing their intellectual property and they do a horrible job of monetizing their developments.

The master agreement reduced uncertainty between partners and provided a layer of deterrence based trust (Gulati, 1995). Apart from the transaction cost advantages (Williamson, 1973), there are institutional advantages to this form of coordination mechanism. This provided an explicit knowledge stock (Polyanni, 1966) that communicated the overarching objectives of the partnership and set the precedence for norms of behaviour. Specifically, the master agreement contract creates a simplified mechanism for new project development, allowing the focus to shift squarely to more strategic issues rather than diverting attention to a lengthy process of contract negotiation and the general expectation of the behaviour in the projects thereafter. This is a further component of the 'rules of the game' established within the early stages of the relationship that enabled far greater scope for value creation for both parties. It also lent credibility and prestige to the relationship in its early years, which encouraged more individuals across P&G and DU to become involved in the relationship. This allowed for accelerated access to resources and project formation, but also allowed both partners to respond to new opportunities to drive growth and to recruit new members (i.e. hitherto unconnected employees for both organisations) into the relationship.

4.4.1.3 Institutional Engagement: Building External Legitimacy

The early activities of the relationship were focused on collecting evidence of legitimacy to garner the external support for initiation and growth. This meant that there was a considerable effort to validate the potential. The relationship between DU and P&G began with early discussions between three individuals dating back to 2010. *(There) was a dialogue with P&G a long time before the relationship actually took shape. He was meeting and having conversation with how we saw the world. How P&G saw the world and just testing out to see if there was an opportunity for a partnership there.*

For instance, P&G provided Durham with the Transformative Platform Technologies (TPTs). *The TPTs brought new budget and were really, we were chartered to do a lot of the work with external partners and that provided the impetus to be able to work with Durham. And then as we started to develop the TPT and what we wanted to accomplish for the company, we saw in Durham that there were lots of partnerships, lots of people that could do things that could be of value to us.* In August of 2010, P&G requested a full and formal document from

Durham with regards to evidence of their capabilities and the resources that will be available should the relationship continue.

Of P&G's nine key technologies proposed, Durham revealed their broad expertise in six areas and provided nineteen pieces of evidence to support this claim. One piece of work was that they shared these technology needs and they were given under headings. One of the things that we were able to do was to spend some time mapping where our expertise lie within each one of those themes. And then to align the right people to talk to them about those things. That is an example of what we did upfront to identify where the fit was.

During the early phases of the relationship, the network needed to enhance its legitimacy to the overarching external institutions. This phase was focused on providing legitimacy to the wider P&G audience. There were also reporting responsibilities. This required the partners to share operational knowledge to ensure that the projects achieved their goals. From the P&G side, this required sharing operational knowledge between and amongst Durham academics and students. This meant greater time commitment to source the internal and external knowledge sources for challenge resolution. Although the relationship was protected under the master agreement, relational trust between and amongst actors began to emerge within the network. The relationship gained momentum as frequency in the interactions gave light to the abilities, intentions, and behaviours.

4.4.1.4 Defining Expectations and Finding Shared Value

Although the master agreement outlined the contractual obligations, specifically the need for specific governance and confidentiality, there was a need for members of the network to focus on the anticipated benefits of the projects. The first project was supervised by a senior member of staff and delivered through a post-doctoral study. The initial assessment by the principle investigator indicated that the project might require a six-month timeline. However, the results were achieved very rapidly, and to the satisfaction of the partner. This initial success served as a jumping off point, in which many other projects emerged.

From there, it was determined that projects would be structured with a combination of academic and industrial supervision. The projects were managed through joint problem solving and greater knowledge sharing as the project continued. Because of this, undergraduate industrial challenges began. These projects are not big enough for grant money but they solve real problems for the company and gives the student business experience. There was considerable studentship support granted by P&G studentship funding and Durham informally

provided scientific consultancy on an ad hoc nature. Already, the evidence reveals a deeper integration than what is implied in the literature regarding the nature of open innovation activities by firms.

This evidence supports the notion that social capital and the development of norms began within the early stages of the network development. Both organizations were offering their resources that extended beyond the contract (Powell, 1990; Zaheer et al., 1998). However, the master agreement and the capability to establish legitimacy to the wider institutions provided the basis for this interaction to emerge.

4.4.1.5 Tipping Point – Early Project Success

These early elements of relational development revealed signed trust building, both partners agreed to start work on applying for a Northeast Regional Growth Fund (RGF) grant. This opportunity would not only require greater opportunities for continued collaboration, but also signalled a desire for greater commitment by both parties. The decision to pursue this opportunity was quick decision. The proposal needed significant attention in a very short time window. They had to move very quickly, and submitted within a couple of months. Once they were awarded the grant, the PhD recruitment took two years to fill. Much of the early relationship building was in response to the requirements stipulated by the RGF.

The successful alignment and coordination during this phase provided the network with the opportunity to grow beyond the contractual elements that often delayed the progress of their other partnerships. The ease at which this was completed provided both sides of the partnership with satisfaction, and leant the relationship prestige. This provided them with the momentum to facilitate greater collaboration.

4.4.2 Network Development Phase 2: Relationship Building for Knowledge Sharing

The relationship building phase focused on building internal awareness of knowledge based resources and trust among the actors. This phase developed in response to the early momentum and success of the initial interactions and projects. This stage focused on establishing the knowledge domains and effectively communicating the capacity for bringing in additional expertise. This stage reflected a level of vulnerability and learning which encourage trust worthiness amongst the partners. This developed a level of knowledge-based trust, developing norms of commitment, and learning through dialogue and setting expectations.

4.4.2.1 Awareness Building – Internal and External

Six months after the RGF was confirmed, additional P&G people came to the university campus to discuss their research objectives and goals. They provided a broad overview of current challenges being face by their organization in a presentation to members of the Durham University Faculty of Science departments. Following the presentation, individual academics could submit applications that proposed various approaches to addressing and solving the challenges. An interview participant recalled that *Everyone had a fair chance to be involved but only a few proposals were selected*. This allowed the challenges to be refined and academics to be involved in the development of solutions. Members of P&G staff selected the winning proposals.

As the initial project formation allowed for the entire department to be involved, it allowed a focus on bringing the entire expertise field into play. However, this form of communication indicated some level of knowledge redundancy to provide the initial communication platform/shared language and goals. The conversations within scientific knowledge and expertise do not always apply to the technical aspects a company might be interested in, or considers how their expertise can be jointly applied. This also allowed for understanding the knowledge resources on a micro-level, as it educated everyone about each other's skills and expertise. Following this workshop, the partners began to share strategically sensitive information with each other.

4.4.2.2 Knowledge Access Building

The next phase of this was to develop a way that they could work together to solve problems and skills that complement their own levels of understanding. People talk about what they have in common, but there is the issue of address the unshared knowledge problem (Stasser, 1992). People don't learn about each other's diverse capabilities until later in the relationship. This was addressed through workshops that illustrated the challenges that were being faced among a diverse set of products. Participants choose the challenges and teams that they felt they may be able to contribute solutions to. The relationship developed exploratory workshops for the project scoping phase – *“The workshop takes the premise that a ‘stretchy’ technology can be thought of as a platform that has enabled the company to defend and grow its position in a market and/or enter or disrupt a market it hadn’t before.”*

Document reads that objectives are two-fold. First objective is *“to develop new application ideas for 10 well developed P&G technologies in current field of application or in*

other fields.” Second is “to recognize areas where further research is required to progress technology application opportunities.”

Due to the size and scale of the relationship, members needed to become aware of the knowledge content and expertise available within the network. Initially, this access based objective was communicated through key gate-keepers that acted to increase connections across the network. This eventually translated to the members developing relationships amongst themselves, aiding in the development of the network size. They hosted monthly technical meetings that were designed to ensure shared responsibility for the project success through joint problem solving. The additional benefit was in the career development of the PhD and Postdocs working on the projects during these joint-problem solving sessions. The room was typically composed of several academics from the university and several technical scientists from P&G. The students developed and delivered the presentation and was lead on answering the questions pertaining to the research. Conversations would typically ensue for approximately 45 minutes after the presentation completed. These sessions also provided the opportunity to communicate developments on either side of the organization.

4.4.2.3 Knowledge Based Trust

The frequency of interaction between the partners gave light to the abilities, intentions, and behaviours. This helped to ensures that the knowledge sharing behaviours, levels of commitment and the interpretation of the results shared were aligned with each other’s expectations. In this form of relational exchange, members of the relationship had the potential to interpret the same results in different ways.

One informant had commented that there was an instance when the partner was working on a similar technique that had been previously proven to be ineffective by their research. This technique would not be sufficient for solving the challenge outlined in the project. This member of the relationship commented that – *“Although some time was lost, the partner reacted and shared prior results.”* This aided in establishing how the knowledge domains could be effectively communicated. This layer of redundancy also facilitated a deeper discussion for joint problem solving, as they offered the capacity to bring in additional expertise. This can be used as a signal to indicate vulnerability yet trust worthiness.

4.4.2.4 Developing Norms

In the development of knowledge and competence based trust, procedures and expectations were defined. This aided in developing norms of commitment and learning the dialogue and expectations. The development of normative behaviours facilitated the shared expectations within the network; such as time commitment and the resources could be shared. This also established how the members expected to collaborate, e.g. the frequency of meetings and levels of autonomy.

This stage also developed norms of reciprocity. As trust developed within the relationship, the more that the individuals were likely to extend their services beyond their current projects. For instance, several of the members of the technical meetings would offer to provide analytical services to those that were presenting. Often, they were not the direct supervision of the student (and not bound by contract) but offered services in goodwill.

4.4.2.5 Tipping Point – Satisfaction yet growing complexities

During this phase the network performance was lauded for its effectiveness, both internally and externally. It presented benefits to P&G that are in fact multi-faceted. As an interview participant remarked, *“There was a speed of translation”* in the pursuit of fundamental science and the *“breadth of knowledge”* as there is access to new knowledge resources and expertise. *“Complexity of solving real world, multi-scale research problems.”* Clearly, the size and time invested allowed the challenges to be solved more quickly than if P&G was doing this on their own. The company was capable for achieving a shorter time scale and essentially reducing development costs. *“we have productivity gains, not cost gains. i.e. we can reach a project completion in three years not six. This is clearly a benefit to industry.”*

Because of the satisfaction, P&G wish to not only replicate the model, but also to grow the current scope of the project. Members of the partnership began to seek support from various institutional stakeholders. Members of the network received prestige and recognition for their unique collaboration. This encourage a greater emphasis on growing the scale to include more opportunities for knowledge exchange. However, as the relationship grew in scale it also grew in complexities. This presented the network with challenges in governance and oversight.

4.4.3 Network Development Phase 3: Relational Maintenance and Oversight

The maintenance phase focused on the continual encouragement of collaborative behaviors and knowledge support. The growth of the network and the scale of the projects across Durham University and P&G departments had increased the complexities in management and with the oversight necessary to ensure that risk and success factors were captured appropriately. Although each of the project objectives and goals were crafted purposefully, the scale of the relational exchange and the potential for more purposeful collaboration across all members of the relationship needed a formalized method for continued alignment. This phase looked to align the factors used for managing multiple projects. Also, there were several opportunities for deepening the collaboration through the pursuit of new projects.

4.4.3.1 Performance Assessment and The Development of the Board

This contingency focused on the refinement more widely communicating the knowledge resources that are embedded within the network to solve performance deficiencies through oversight and mechanical based trust mechanisms. A key goal was to enhance the levels of explicit knowledge stocks and the usage of standard tools to improve communication. There was also a focus on developing key success factors and overarching documents that could be used to use as a platform for sharing knowledge among a larger number of individuals. As the complexity of the relationship grew, the potential impact of the activities within either organization grew as well. As many of the projects were built in an autonomous and organic fashion, finding a common ground for analysing the levels of success became essential.

In 2013, the relationship developed a strategy planning board. Initially, the relationship was managed purposefully with scientific advisors assessing project proposals and performance. The board was enacted as a step of analysing the outputs as well as assessing progress and at risk progress for current projects. Much of the focus of this group was to handle the complexities of external institutional engagement with the organization (e.g. departments), the wider university community, the external stakeholders (e.g. SME partners, University Partners, and Research Centres), and research councils. Additionally, the board focused on the development of future strategy.

The success of the early phases and the increasing recognition of the partnership activities stimulated a desire to further develop more projects and extend the life of the relationship. Following the initiation of the board activities, the 2013-2014 academic year required significant commitment from many individuals at both organizations. This involved

decision-makers from strategic areas within P&G and Durham University. The board meetings were hosted once a month until projects were defined in a method that could be clearly communicated to external funding agencies, either within the UK Research Councils or within other departments at P&G.

4.4.3.2 Resource Allocation

The board also focused on addressing the resource allocation needs of the network. A focus of board was in the assessment of projects and the intended objectives/goals of each project. Through this exercise, the board members could discuss the knowledge capabilities of the network and potential alignment between members to address resource deficiencies through identifying potential sources of solutions. This was also done to enhance institutional legitimacy within the wider and external network of connections. During this phase the relationship expressed interest in developing new forms of projects. They aimed to enhance the scale of the collaboration through providing access to their external social capital.

There was also a large emphasis on defining future objectives and opportunities, per calls made by the Research Councils and the organization's objectives. The board meetings often discussed the scientific capabilities of either organization to achieve certain initiatives.

4.4.3.3 Joint Problem Solving and Network Behaviour

The coordination efforts of the board ensured that the network activity was stable and was provided for in terms of resources. This allowed for a level autonomy for the researchers to avoid extensive paperwork. However, as the board determined more methods of sharing explicit knowledge, this increased the volume of administrative work the researchers working on the projects. There were also new projects developed under the remit of a different collaboration format and new partners that decreased the early momentum of the initial project formation. As new members became involved, the board needed to identify and delegate members operating within the network to acclimate and standardise practices.

The board recognized that a level of success from current projects were related to the technical transfer meetings that were hosted once a month. The scientific staff engaged in technical transfer meetings to discuss and problem-solve issues on the active projects. The participants included academics and students at the university, as well as research staff from P&G. The meetings were centred around a student presentation/project, which allowed members of the partnership to make recommendations for further steps in the project development.

As projects were nearing completion, members were anticipated to become latent ties and there were concerns regarding the potential for defining the appropriate means in which some standard processes could be communicated to external entities. The focus of this time was illustrating the highlights of performance and the capabilities of the network. There was intense interaction between the board members during this time, with monthly meetings and projects completed.

4.4.3.4 Tipping Point: Stabilization and Enabling Innovation

The network faced risks of becoming path dependent and losing momentum during this phase. There were concerns that management practices could be developed too tightly and can preclude collaboration. The balance between calculated risks and fostering innovativeness through separating the administrative and entrepreneurial tasks. The board (management) needed to ensure that the network was strategically and intentionally connected to the various content specific goals. However, there was evidence that some areas might be too tightly connected may cause bottlenecks and knowledge redundancy. Additionally, participation in the technical meetings was declining as junior members oscillated out of the relationship due to project completion. There was evidence of people becoming too connected to the same people and, thus, lack of exposure to novel knowledge sources. Also, the researchers needed to feel a level of autonomy.

4.4.4 Network Development Phase 4: Renewal and Growth

The fourth and final stage shifts the focus of the network to the strategic focus on the renewal and growth of the network. This stage placed emphasis on opportunity identification through new network partners and new project proposals. This phase was enacted in response to the evidence of stabilization within the network and the loss of momentum that occurred as projects completed and prior ties became latent. The board and members of the relationship focused on rejuvenating the momentum experienced in the early phases of the network development, through the introduction of new projects and recruitment.

During this phase, network members with long standing tenure, within the relationship, were granted more opportunities. However, the project scopes followed a different format than the previously developed design. Students of the network were required to spend time in P&G's laboratories for a portion of the project.

4.4.4.1 New Opportunity Identification and Network Growth

The approaches taken for new opportunity identification became more strategic. The members of the board looked to build corporate sponsorship from both organizations and secure bridges with ties to new partners to grow knowledge diversity. There were two different approaches to this phase. First, the members of the board pursued potential linkages with individuals that were external to the relationship but internal to either organization. Through linking across the different departments, there is potential for accelerated internationalization for the university. P&G's markets are segregated geographically, with a North America, Latin America, Western Europe, Eastern Europe, Middle East, and Africa (EMEA) and Asia. Currently, the relationship has an established presence in most regional innovation centres in Western Europe, and developing bridges with North America, Asia and EMEA.

The other approach taken was linking with new external, non-competing partners. The partners looked to establish research consortiums with new organizations and universities. Durham's commitment was to link new potential, non-compete partners for larger scale collaboration.

4.4.4.2 New Project Development

A continuous focus of this network was in developing new ideas for future work. Most often, the organizations hosted collaborative work shops. However, several of the projects had developed from the findings of earlier work completed within the relationship. This allowed members of the network to address the potential for future opportunities as well. The group needed to rejuvenate the engagement through the definition of new projects and members to ensure the relationship maintained vitality.

4.5 Chapter Discussion

The focus of this chapter was to illustrate the components that facilitate social capital accumulation over time, and the actions/response that contribute to the growth and development of the network. The relational development behaviour has been strongly associated with providing an environment conducive to knowledge exchange (Carmeli & Azeroual, 2009). As evidenced in the analysis, there were varying conditions that contributed to how the relationship has developed over time and how the implementation of the conditions may have resulted in various developmental outcomes, as well as how these conditions have contributed to the multi-faceted benefits for each of the parties' experience.

Recent studies have called for a focus on relational behaviour (Hughes et al, 2014) and social capital development behaviours (Ng and Feldman, 2010). Studies into network development have focused on survival functions, network membership and the impact of network structure following significant events (Carroll & Hannan, 2000). However, relational context plays a significant role to the functioning and responses to environmental changes that occur over time. To the researcher's knowledge there has not been an ethnographic study on the development of an open innovation network built between a university and business. Cooperation, advantage, and trust can be built over time (Huemer, 2014). Networks are not static, and the oscillation of new members and internal/external pressures influence the resources available and the knowledge creation therein (Nonaka, 1994; Hughes & Perrons, 2011). As well, as the impact of embeddedness and the effects of social capital development over time (Ng and Feldman, 2010).

The analysis began with an overview of pre-existing platforms and motivational triggers that fostered early development of the relational exchange. Several scholars contend that the success or failure of strategic relationships is dependent on the existing similarities between the organizations. Several contingencies existed including prior academic-industry experience, institutional pressures, and constrained resources. However, it is not possible to identify all the contingencies associated with a relationship to develop a contractual arrangement prior to implementation. This is why the alliance literature has begun to consider trust and the development of social capital as the theoretical explanation for how partnerships can be maintained (Zaheer et al., 1998).

The successful transition to further stages in network development was dependent on the appropriate responses and actions taken to the tipping points. Each phase presented a new dynamic and challenge that required complex social processes to be coordinated; which had implications for the network structure and operational focus, and demanded actions to shift the organizational focus and to maintain the vitality of the relational exchange for continued value creation. The extent to which value can be created from opportunities presented by network content and structure can only be realised through the behaviour of the individuals acting within the social system. It aims to provide a temporal perspective of relational context and changes over time. The research investigation provides an extension of Cross & Parker's (2004) stages of network development framework. The aim is to understand the structure, the network pressure, and the various relational themes that emerge.

A core challenge identified by the partners lied within the potential for conflicts about knowledge ownership and commercialization of developed technologies. Additionally, there was a common dissatisfaction between both partners in defining a sustainable business model for this type of relationship, and this provided the common language necessary to initiate discussion with key actors at the forefront. Within that challenge, a further complication stemmed from the tendency among university and business relationships to have idiosyncratic contracts for each new project, the implication being that within any one relationship, many different legal contracts could be in place each accounting for a specific project. The governance and project management complexity this creates is inefficient and unattractive to grow an overall university-business relationship. To minimize the negotiation process, simply the governance of the overarching relationship and speed up project development and approval, this relationship established a 'master agreement' to govern the nature of knowledge ownership, intellectual property and technology commercialization on a scale that covers the university rather than any one individual. This governance approach is unusual and not standard practice but allowed the relationship to grow and scale very quickly. For example, in the first year of the relationship alone, 7 number of projects were set up and over the course for the next 4 years, a further 55 projects were established.

Apart from the transaction cost advantages, there are institutional advantages to this form of coordination mechanism. Specifically, the master agreement contract creates mechanical trust that simplifies new project development, allowing the focus to shift squarely to more strategic issues rather than diverting attention to a lengthy process of contact negotiation and the micro-management of projects thereafter. This is a further component of the 'rules of the game' established within the early stages of the relationship that enabled far greater scope for value creation for both parties. It also lent credibility and prestige to the relationship in its early years, encourage more individuals to become involved in the relationship. This allowed for accelerated access to resources and project formation, but also allowed both partners to respond to new opportunities to drive growth and to recruit new members (i.e. hitherto unconnected employees for both organisations) into the relationship.

From the analysis, there have been four major tipping points that were identified and resulted in the further stages of development of the network: initiation, relationship building phase, maintenance, and renewal. The investigation then moves to reveal the functioning of the initiation phase. The initiation phase focused deeply on understanding each other's mutual needs as well as how to leverage capabilities and resources that each partner could bring to the

table. For the university, this meant devoting diverse expertise, drawing external partners, and negotiating fair IP rights. For the business, this meant ensuring that academic goals were still capable of being achieved and bringing unique challenges to the table. The relationship building phase focused on building internal awareness of knowledge based resources and trust among the actors. The maintenance phase focused on the continual encouragement of collaborative behaviors and knowledge support. The fourth and final stage shifts the focus of the network to a renewal and growth phase, which resulted in an emphasis on opportunity identification through new network partners and new project proposals.

The transition from each phase was characterized by key points that demanded actions a shift in the organizational focus to maintain the vitality of the relational exchange for continued value creation. The successful transition to further stages in network development is dependent on the appropriate responses and actions taken to the tipping points. Each phase presented a new dynamic and challenge that required complex social processes to be coordinated; which had implications for the network structure and operational focus. This research site and this analysis offers intriguing insight into the dynamic processes of relational exchange due to the self-organizing processes and methods employed in the construction and growth of the network. As mentioned previously, this relationship was built in a self-organizing and organic way, which indicates that network fragmentation benefited the development of the relationship. An over focus on rigid mechanisms and planning processes might dilute the adaptive nature which contributed to network growth. This network addressed these obstacles by being flexible. Rigid planning procedures may have reduced the ability to be responsive to changes. These findings suggest that multifaceted adaptive processes are essential, but are often overlooked in network studies.

A final, yet key, theme that emerged in this investigation was the need to continually engage with external institutional forces and to continually manage legitimacy through all phases of the network development. The group needed to define the tools that were necessary to communicate the 'how' and the 'why' effort should be expended on development to a wider audience, indicating that the network activity extends beyond the partner organizations and has an impact beyond the boundaries of the relational exchange.

4.6 Conclusions and Implications:

This research aims to marry the body of literature on network dynamics with the body of literature on open innovation. This research also has implications for policy makers,

managers and academic working within the realms of university-business research collaborations as it reveals the process in which networks of this type may be built though providing a view of a functional relationship. “Network analysis enters into a process of model development, specification, and testing in a few ways: to express relationally defined theoretical concepts by providing formal definitions, measures, and descriptions, to evaluate models and theories in which key concepts and propositions are expressed as relational processes or structural outcomes, or to provide statistical analyses of multi-relational systems” (Wasserman and Faust, 1994: 5). Different than traditional social science statistics and requires different approach. Standard social science focuses on the outcome, while SNA focuses on the inclusion of concepts and information of the relationship between units in the study.

CHAPTER 5 NETWORKS EMBEDDED WITHIN NETWORKS (UNIVERSITY-BUSINESS CONTEXT)

5.1 Introduction

This chapter of the thesis focuses on providing an analysis and overview of the various networks that are embedded within university-business open innovation relationships. As presented in previous chapters, the body of literature on the university-business relationship is typically approached from the perspective of understanding the institutional pressures on the functioning and performance outcomes of this relationship; such as the impact and complexities funding structures and the performance of university-business relationships (Benner & Sandstrom, 2000; Etzkowitz & Leysdesdroff, 2000; Park & Leysdroff, 2010; Hicks, 2012). However, there has been little research that acknowledges the breadth and depth of network involvement outside of the focal relational exchange, and the impact that various levels of network activity on the overall function of this form of relational exchange.

This chapter also focuses on illustrating a common conceptual problem in studies that utilize a network approach to understanding the performance and management of inter-organizational relationships. The mode of analysis often varies in terms of the objectives of the researcher (Laumann et al., 1983). For instance, an open system network study might reveal dichotomous ties between many entities, however some researchers focus on revealing the relational depth and context between two partnering organizations. The variations between the macro-level and micro-level views presents conceptual issues in the analysis as it makes it difficult to identify the boundaries of the network and all the potential resources that may become available, especially in the instance of an open system (Laumann et al., 1983; Wasserman & Faust, 1994). The micro-level approaches to analysis limit the boundaries to individual level and the types of relations embedded within (Kilduff & Tsai, 2003). However, the units of measurements utilized in studies often have significant variations (Sedita, 2008). This is made more complex research suggests significant variations across organizational settings (Ahuja, 2000; Provan et al., 2007) which make them more difficult to manage and coordinate (Doz & Hamel, 1998). These are typically viewed as multi-plex networks and are governed by several different forms of relational linkages.

A network is often inter-twined and impacted by other networks in varying ways. As evidenced in Chapter 4, the partners of a university-business relational exchange must respond and are impacted by several external forces. This chapter of the thesis reviews the various ways

in which a university-business network can be analyzed and the impact that various network structures have on the management and coordination of the innovation process.

5.2 Analysis Technique and Data Employed

The analysis for this chapter emerged following the thematic analysis in chapter 4. Specifically, this chapter focuses on providing an overview of the networks embedded within the P&G-Durham University relationship. The data employed for this investigation was a combination of direct observations at the executive board meetings, semi-structured interviews, and archival documents. As the purpose was to develop an understanding of the extent and influence of network activity, this chapter aims to understand the volume of relational links impacting the performance and outcome of this relationship. Socio-grams were created to illustrate the connections between made nodes within the network. This chapter is intended to clarify the network boundaries and the impact of complexities on the management of the innovation process with university partners.

The patterns presented in this chapter are aimed to reveal the relationships between actors without acknowledgment for the behavioural attributes for a broad level of analysis. The literature review identified that the network studies are impacted by the lens in which researchers adopt the ‘whole network’ for analysis, insomuch that they also account for the compositional and behavioural elements that might influence a network activity. This study seeks to illustrate the impact of the macro and micro level views and their inter-relationship to fully illustrate the interactions between the formal and informal relational ties that exist among actors. To date, the body of literature in characterising a full network employing both techniques is limited. This study seeks to address the limitations of common data access issues and looks to describe the multi-level interaction and relational patterns that are embedded with an existing open innovation dyad to contribute to the social network analysis literature.

5.3 The Institutional Effects of External Parties

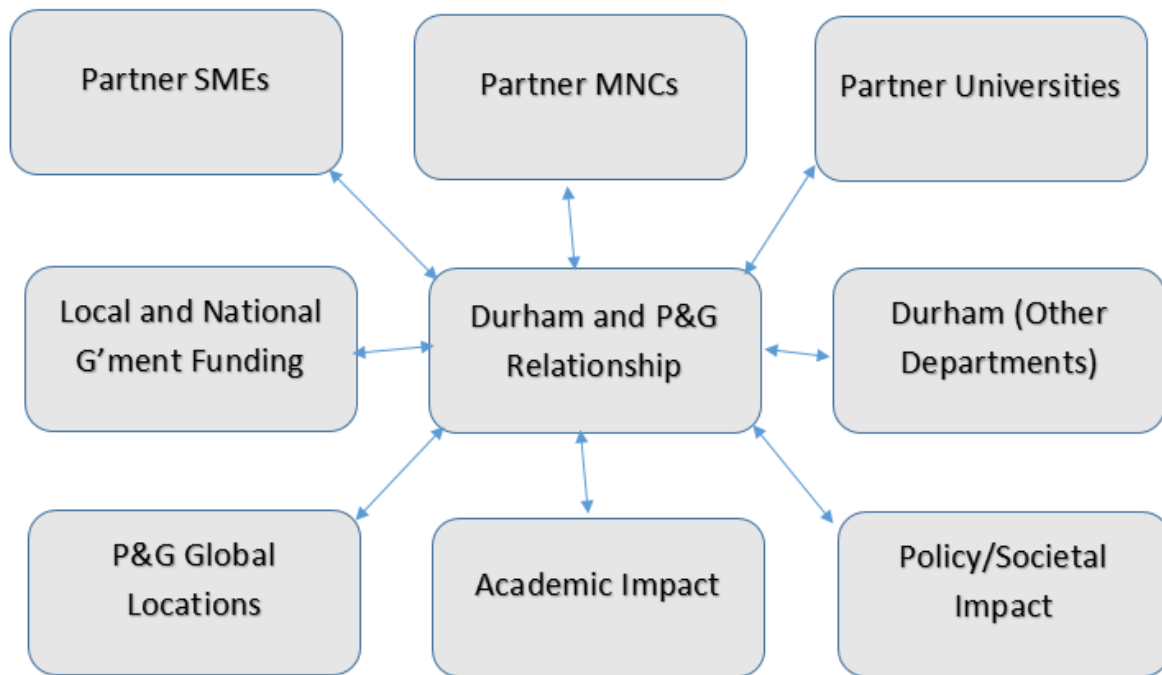
The volume of inter-organizational relationships a university and/or a business hold (either before or during) are likely to contribute (or impact) this type of collaboration. An open systems approach to a network analysis focuses on the opportunities and potential transfer (or constraints) of social capital to actors on the external fringes of the network structure and how the interplay of authority, legitimacy, and leadership effects the actors internal to the relationship (Kadushin, 2011). An open systems approach may illustrate the extent to which weak ties and external novel resources characterise the ‘access’ the network has through a less

bounded view (Jarillo, 1994; Cross & Parker, 2004), but can lack the density necessary to reveal multiple levels of relational channels and behaviours.

There are more than 40 external parties affiliated to the overarching P&G–DU relationship. This network is characterised by governmental units, public bodies, funding councils, non-competing companies, and other universities. It is apparent that knowledge and resource flows occur through a variety of internal and external subunits. Each of these stakeholders presents a unique blend of opportunities, yet a distinct set of challenges to the overall maintenance of individual projects let alone on the overarching relationship. For example, the alignment of expectations among diverse partners is complex. Each partner's unique contributions and needs must be carefully coordinated to facilitate the acquisition of valuable resources. But such support also contains important implications for governance and coordination.

Realizing the extent of partners within the network, boundary specification was set to limit data collection between actors at the University and P&G. There is considerable evidence that the knowledge flows from external sources are extensive. For instance, the triple helix funding structure and the philosophies of CPI. This relationship facilitates access to external engagement on a broader scale. However, each relationship for potentially represents a different level alignment. Additionally, their level of influence varies as well in terms of formal mechanisms (e.g. reporting and impact) and informal mechanisms (culture, trust, and behaviour.)

Figure 13 – External Influences from the Partnership Network



The most influential example of this was the role of a regional funding body in the early stages of the relationship that, in return for several million Pounds of research funding, implemented oversight by inserting a third-party collaborator, requiring the involvement of local businesses, and necessitating regular joint meetings of projects funded through the initiative. While this might be interpreted as bureaucratic oversight and interference into the governance and coordination of projects central to the overarching P&G-DU relationship, this set of requirements provided a further platform for increased frequency of meetings between the network members and particularly between P&G and DU in the early stages of the relationship. By requiring greater interaction and coordination of activities, this helped to accelerate the maturity of the network structure between P&G and DU, adding momentum to the growth of the relationship.

The impact of institutional forces should not be ignored in terms of its importance or value to the development of the overarching P&G-DU relationship. While it may be tempting to focus inwardly on the relationship alone, members of the ‘open’ network can bring valuable resources and knowledge but their actions in specifying contingencies onto the management of the relationship is also important for how the overarching P&G and DU relationship developed. Treating these external parties as valuable partners instead of as mere resource holders can path-dependently shape the relationship and its effectiveness. This grew the social capital

within the relationship as well as the social capital with external parties, benefiting the stakeholders financially through resource acquisition and non-financially through improved governance and knowledge generation. Through allowing the partners on either side to access the resources within their personal network signifies trust, as revealing such contacts has the potential to jeopardize reputation and established social capital.

The direction and influence of the activities occurring within this level of network influence the actor's access and awareness of external resources. The boundaries of this 'open' network is likely to include a vast number of actors and is beyond the scope of this study. It must be acknowledged that one of the advantages of the open level network ties was its provision of financial resources to rapidly set up new projects and that the degree of the linkages that internal actors hold is key to ensuring the vitality, sustainability, and continued productivity of novel resources as it promotes heterogenic knowledge. It also lent credibility and prestige to the relationship in its early years, encourage more individuals across P&G and DU to become involved in the relationship. These individuals reflect the individual interactions in the scientific network within the P&G-DU relationship, and is discussed next.

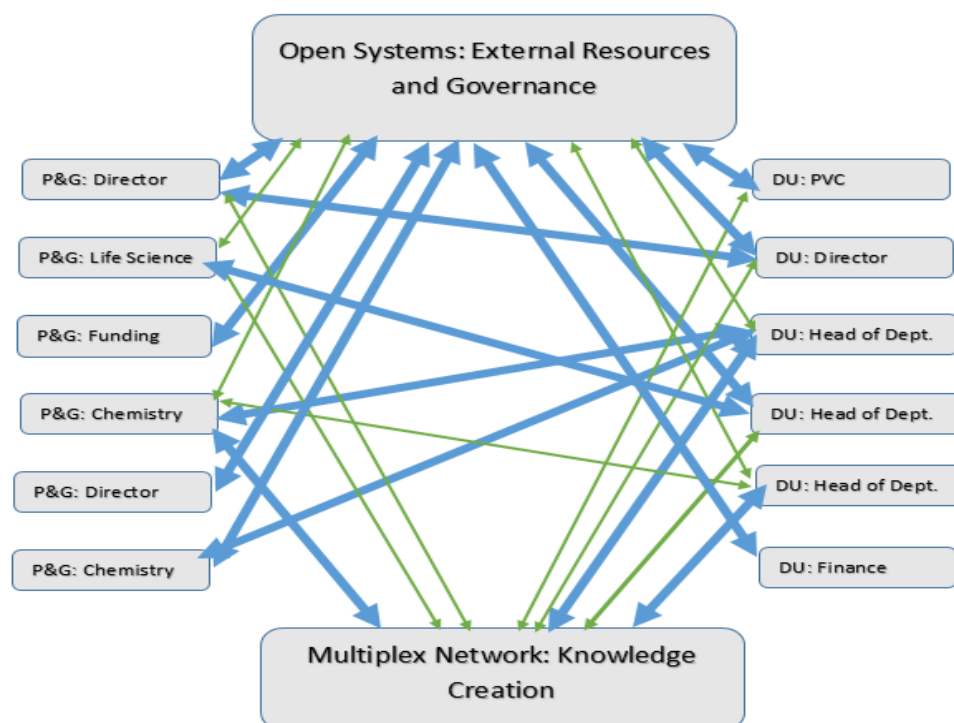
5.4 Governance (Board-Level) Network

The network within a university and business collaboration is more dynamic than typical one mode network analysis. A one mode network would indicate that all the actors are from a single entity, and that network is comprised of actors for a singular social system with aligning goals. A network with actors from two different social systems are called two mode network. For instance, a business's overall objective lies within marketable value creation whereas a university has the objective of knowledge creation. The partners share differing overall objectives, for instance profit and not-for-profit, this gives rise to a two-mode network. As such, this type of relationship is often characterised to have bi-directional resource flows (Wasserman & Faust, 1994; Hanneman & Riddle, 2005). Dyadic analysis of two mode network is a technique that seeks to describe the relationship ties between two actors and is characterised by several different forms linkages that tie the organizations together. "Dyadic analysis focuses on the properties of pairwise relationships, such as whether the ties are reciprocated, or whether specific types of relationships tend to occur together" (Wasserman and Faust, 1994: 18).

The dyadic level refers to the organisational network between P&G and DU. Prior to any further network ties forming within the 'relationship' (defined as the overarching relationship between P&G and DU), an organisational network first needed to emerge to set in

place the governance and transactional coordination that would regulate the projects that would develop within the P&G and DU relationship. As mentioned in the previous chapter, the overarching governance (e.g. the board) formed to monitor the relational dynamics, and begin formal a process of capturing its successes to demonstrate its value and legitimacy to internal (e.g. corporate headquarters, business units) and external (e.g. suppliers, funding bodies) stakeholders. Figure below is the socio-gram created for the board level interactions.

Figure 14 - The Board Interactions



The development of the board led to an extensive action by the network for the benefit of the P&G-DU relationship. There was purposeful action to identify and connect with and from the existing but separate set of ties with external parties held by individual actors within P&G and DU. While offering its own resources, and presenting its own opportunities, the actors operating within this network had a profound effect on the governance and coordination of the overarching P&G-DU relationship. Therefore, the socio-gram (Figure 12) further illustrates the interactions between these varying networks.

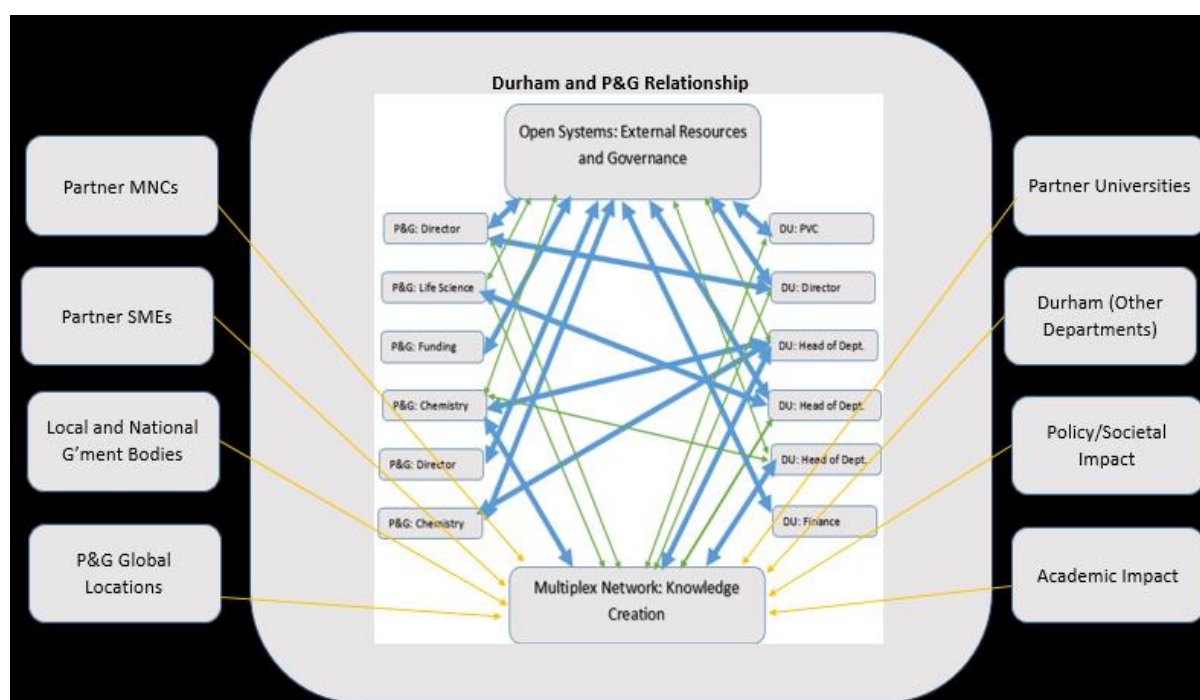
However, the dyadic interactions were also observed in the new product development network built between the R&D scientists. This is the network that shares the complex knowledge necessary for innovation performance. While it was anticipated that the

observations would include actors from both organizations, it became apparent that the systems of activities were embedded within a broader range of network activities and external parties. The next section presents the analysis of the scientific network built for knowledge exchange.

5.5 Scientific and New Product Development Network

The activities for value creation take place at this network level even though the processes governing that value creation may take place elsewhere. This level of network is driven by human actors, who are characterised by diverse knowledge resources and roles that contribute to the overall functioning of the network. For instance, the formal coordination has assigned categorical roles that define everyone's anticipated contribution. However, the diversity and access to knowledge-based resources are impacted by the extent to which the individual actors are impacted by human agency, absorptive capacity, and the overall knowledge of capabilities within the network that facilitates the collaboration within the overall network. A multitude of social structures define how knowledge acquisition opportunities are either enabled or constrained, and the extent to which value is created.

Figure 15 – Influences on the Science Network



Knowledge and resource flows occur through a variety of subunits. The subunits are characterised by a variety of knowledge content roles and behavioural components. Most of the network activity has been observed within a network composed of actors from the physics,

chemistry and biology departments within Durham University and the technology managers within P&G. While the board was developed to insulate the institutional and external network activities, there were still evidence of significant pressures and surmounting expectations as more became external members became involved. Additionally, this network needed to address a communication and joint problem-solving forum where knowledge diversity and the process of innovation could emerge.

There has always been an interrelationship of the natural science disciplines, as each of these disciplines performs a specific role relating to the others. Chemistry is focused on understanding the chemical composition of our world and is often referred to as the central science due to its capability of connecting disparate fields within the physical sciences (Kunn, 1962). As such, a general definition of Chemistry is a study of particles and the chemical bonds. The laws of physics aid chemists in determining the underlying forces that govern movement of the particles under observation. Therefore, Physics is generally defined as the study of properties and movement of matter and energy, which can be associated with anything that moves. There is a long-standing relationship between the cross integration of the studies of physics and chemistry. Biological studies, which are frequently called life sciences, cannot be reduced to chemistry due to theories of evolution and a level of unpredictability of molecular and cellular behaviour. The biological inter-relationship occurs using the laws of physics to understand movement, and certain chemistry based methodological approaches which are employed to understand the composition of cells. This basis aids the communication platform for the shared language requirement of deriving innovation. Academic language from diverse disciplines has the potential to limit communication in this context, as specialized terminology can limit the extent to which 'outsiders' can internalise.

A significant and understated benefit of the industrial context and the development of technology at the university lies within the ability to connect inter-disciplinary approaches within the remit of a single project scope and fosters deeper integration into the multi-discipline approach to solving scientific challenges. This unique configuration allowed a platform to inter-relate academic departments extends beyond the traditional departmental format of many university structures. For instance, technical challenges that focused on personal care could integrate project scopes across biology, chemistry, physics, and mathematics. This fosters the potential for novelty to emerge as it not only features a level of knowledge redundancy to allow for absorption but also exposure to diversity in new knowledge acquisition.

5.6 Chapter Discussion

This chapter of the thesis reviews the various ways in which a university-business network can be analyzed and the impact that various network structures have on the management and coordination of the innovation process. It aims to define methodological insight to the streams in which a university-business network might be studied through illustrating the variations between the macro-level and micro-level views. The variations between these view presents conceptual issues in the analysis as it makes it difficult to identify the boundaries of the network and all the potential resources that may become available, especially in the instance of an open system (Laumann et al., 1983; Wasserman & Faust, 1994).

The micro-level approaches to analysis limit the boundaries to individual level and the types of relations embedded within (Kilduff & Tsai, 2003). The process of innovation and sharing knowledge occurs within the micro-level. However, the university-business relational exchange can be impacted by several significant and powerful external forces and, as evidenced in Chapter 4, the management and coordination of those external institutions plays a significant role on the internal behavior, opportunity identification, and internal management.

As evidenced in the university-business section of the literature review (2.3.3), there are significant efforts and pressures from various external institution on this form of relationship within the United Kingdom. Recessionary pressures and evidence of strained public resources has influenced a greater call from Government for greater university-business engagement across the nation and for shared resources in the pursuit of technology development. The Government hopes to influence the innovation landscape for higher levels production and to stimulate growth economy by better utilize national resources (Salter & Martin, 2001; Metcalfe, 2010; BIS, 2012; Wilson Review, 2012). This is often done in the format of engaging MNCs, SMEs, Universities, Research Institutes, etc which may present opportunities for diversity and heterogeneous knowledge within the network (Knott, 2003) through providing access to weak ties (Granovetter, 1973; Burt, 1992).

However, as the universities connect and their network increases in complexity, a potential for network overload emerges (Marriotti & Delbridge, 2012) and may undermine the ability to develop the integration and relational linkages that are necessary for the complex knowledge transfer (Uzzi, 1996, 1997) associated with innovation development as the value of the knowledge acquisition is largely dependent on the composition of the knowledge shared (Polyani, 1966) in the micro-level network. The resources necessary to ensure that all links are managed appropriately relies on the ability to effectively coordinate multiple levels of network simultaneously.

CHAPTER 6 SOCIAL STRUCTURES, CONTENT, AND BEHAVIOUR IN UNIVERSITY-BUSINESS COUPLED OPEN INNOVATION PROCESS

6.1 Chapter Introduction

This final empirical chapter of the thesis aims to analyze the structure, content, and behavior of the micro-level network that focuses on the scientific exploration and in which the innovation emerges. The activities for value creation take place at this network level even though the (formal) processes governing that value creation may take place elsewhere. As revealed in chapter 4, the master agreement served as an initial governance mechanism. This act provided the relationship with deterrence based trust. However, the underlying assumption of opportunism has significant implications for an inter-organizational network of this type, as inter-personal trust and relationships are required for facilitating complex knowledge exchange (Uzzi, 1996, 1997). Therefore, this chapter focuses on revealing the potential interaction patterns that are facilitated through the formal network structures and discusses the way actors might be strategically coordinated to facilitate knowledge access and diversity. The formal structure provided interesting insights into the ways that knowledge may be accessed within the network, however it is widely accepted that there are striking contrasts between formal and informal networks (Cross et al., 2001; Kadushin, 2012).

The formal coordination has assigned categorical roles that define each individual's anticipated contribution (e.g. administrative, biological, physic or chemistry based problem solving). The informal (or internal) structure is embedded in what is known as the hybrid network structure. The informal relational ties are characterised by a variety of inter-personal relations with varying degrees of strength. These formal and informal structures influence the development of each other are cyclical in nature. The prior evidence supports that this relationship is characterised by multi-relational ties and compositional elements. The informal relational ties are characterised by a variety of inter-personal relations with varying degrees of strength. It is theorized that formal and informal structures influence the development of each other in cyclical nature. Therefore, this thesis addresses the call made by Kadushin (2012) to illustrate informal network facilitates collaborative behaviour, such that it results in value creation, innovation, network growth, and sustained results.

This relationship is further characterised by various forms of relational ties and compositional elements will further aid in characterizing informal linkages and promotes cohesiveness. A multitude of social structures and relationships define how knowledge

acquisition opportunities are either enabled or constrained, and the extent to which value is created. The interactions between each subunit is characterised by a differing relational ties and content goals are likely to affect the type of relational ties that hold the group as well as the intensity of interactions. the diversity and access to the knowledge resources available within this network is complicated by the extent of behavioural and social complexities, and the overall knowledge of capabilities within the network that facilitates the collaboration within the overall network, which has the potential to explain the true nature of collaboration beyond the contractual elements.

6.2 Analysis Techniques: Socio-Matrix of the Innovation Network

The analysis for this data set focuses on ‘quantifying the qualitative’ through the creation of socio-grams and matrices to represent the data in line with the social network analysis techniques. This stage of the research design adopts a descriptive stance in that it then seeks to measure and describe the influence of the contingencies that were revealed during the preliminary exploratory stage. The descriptive research design seeks to crystalize the network structure of a particularly successful example of a university and business relational dyad in its entirety. The intended outcome is to describe the ways in which novel and innovative outputs might influence outcomes from within an active network in a systematic way. Per Churchill (1999) a descriptive research design is best applied when the research topic is focused on revealing the characteristics of particular social groups, and the relationships between variable. This is necessary to illustrate the complex dynamics and interactions among network structure, content, and behaviour on both sides of an open innovation relationship dyad. Therefore, the descriptive phase adopts a mixed method approach which combines and triangulates qualitative and quantitative data to enhance the reliability of the interpretations.

This exercise provided the opportunity for an objective display of the formal organization and task interdependence. The formal network through constructed by charting who has a contractual obligation to connect with whom within the network. The board level socio-gram and the extent to which the interaction patterns extend beyond internal network was developed from the qualitative investigation. The identification of the defining phenomena of the pockets within the social structure of interest was intuitively defined. The analysis has focused on the creation of a single variant, non-directional socio-matrix was developed for the scientific network based on the contractual linkages between actors. This reveals an extent of centrality, prestige, and position of the actors within the idiosyncratic pockets within the collaboration (Wasserman and Faust, 1994). The data was then analysed using UCInet to

present objective displays. This matrix was constructed with 137 actors from both sides of the relationship.

This chapter provides objective displays of the formal network structure as coordinated by contractual arrangements and the obligatory task interdependence as outlined in the Master Agreement. This will illustrate the network connectivity among actors' specific functions, which has been assumed to be the guiding force in facilitating the generation of the knowledge and innovation outputs. As will be illustrated, the formal structure is coordinated in a way that does encourage and opportunity fluidity among the members. Analysis of these features aids researchers to understand how opportunities or constraints may emerge in the social structure (Adler and Kwon, 2002; Burt, 1995; Granovetter, 1973) utilizing concepts such as density, cohesiveness, clusters and/or transivity (Hanneman and Riddle, 2005).

This chapter presents evidence of distinct variances between the formal and informal coordination through the observations made during this level of analysis by triangulating with previously collected qualitative data collection. Researchers utilizing social network analysis often rely upon relational data to reveal the interdependence and actions of actors within a network. Based on observations of actors' positions and the density of their connections, scholars working in this area frequently rely upon objective data to validate their theorizing. Recent attention has been given to the benefits of engaging with both quantitative and qualitative data and analysis, however it is not a standard practice within this methodology. Proponents of utilizing qualitative approaches to analysing social networks emphasise the potential for this type of analysis to be utilized during exploratory stages of the research. However, the approach taken for this chapter takes a descriptive stance and aims to provide an overview of the variances between formal and informal network activities.

This chapter aims to contribute to the social network analysis literature through triangulating observations of the informal interactions in the qualitative data collection, which has implications for how each actor obtains or pursues the opportunities (or constraints) available within the relationship, reflecting a limitation of contracts. This study seeks to identify and map the relational elements that enable (or constrain) the cross-functional resource flows that enable innovation and define the interactions between network structure, content, and behavior.

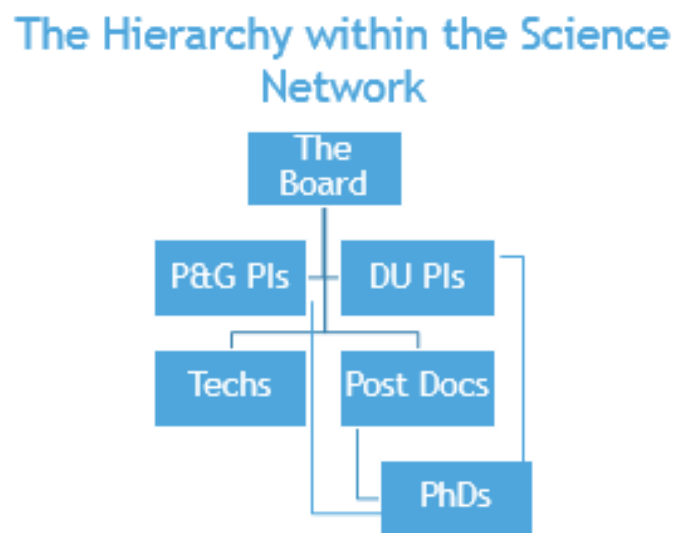
6.3 Overarching Governance and Hierarchical Structure

This chapter focuses primarily on the activities of the science network, which are influenced by a wide range of external activities occurring within other network levels. This section discusses the activities of the overarching governance impacts the abilities for individuals to collaborate within the network. Prior analysis (in chapter 4 and 5) conducted within this thesis focused on the development and pressures of the overarching hierarchical activities of this form of relationship. As mentioned earlier, the initial challenge that the partners identified as a barrier to collaboration within this form of relationship lied within the potential for conflicts about knowledge ownership, commercialization of developed technologies, and the ability to scale collaboration to enhance the knowledge heterogeneity (Knott, 2003) for innovation. Evident within that challenge, there was a tendency for partners to develop other university and business relationships with idiosyncratic contracts for each project developed, indicating that the projects had the potential to be operate within silos and limiting external collaboration. The implications of this form of relational exchange resulted in many different legal contracts accounting for a specific requirements and differing expectations per project. The project management complexity this creates is inefficient and unattractive to grow an overall university-business relationship. This standard mechanism facilitated the explicit knowledge stock to govern the nature of knowledge ownership, intellectual property, and technology commercialization on a scale that covers the university rather than any one individual and allowed the conversations between members to “*focus on the interesting science.*”

This governance approach is unusual and has not been adopted as standard practice, however it provided the relationship with several benefits; e.g. the size and scale grew very quickly which provided for heterogeneous knowledge access whilst also eliminating a common barrier that precludes the ability for large scale collaboration. This also reduced the negotiation time and allowed for the relationship to focus on network development activities that were atypical in comparison to previously developed relationships. The advantage of a single master agreement is that it focuses the attention of employee members on new project development and emerging opportunities for further collaboration. In turn, the rapid growth of network ties created further coordination problems that an overarching contract could not manage or resolve. The master agreement provided a formal network structure, as the proceeding project proposals and contracts bound individuals by task interdependence and expectations of the partners.

The Board was formed to monitor the progress of projects, stabilizing the relationship, and begin formal a process of capturing its successes to demonstrate its value and legitimacy to internal (e.g. corporate headquarters, business units) and external (e.g. suppliers, funding bodies) stakeholders. This action led to an extensive affiliation network to be formalized for the benefit of the P&G-DU relationship from the existing but separate set of ties with external parties held by individual actors within P&G and DU. Figure 15 is representation of the formal hierarchal structure in terms of roles and responsibilities. However, the analysis presented in the proceeding sections will illustrate that the resource access and the knowledge sharing within the network does not follow a rigid process.

Figure 16 - Hierarchal Structure



The social capital and trust mechanisms, that developed within the board, set a precedence for the network. This level leadership helped to clearly define the roles and expectations of the other network members and established the norms of conducting business. While there were clear differences in the expectations for members at higher levels of the hierarchy, the communication channels were flattened to encourage lateral exchange of ideas and human capital development for the students engaged.

The board was composed of senior members from both organizations. On the Durham side, members consisted of heads of department, pro-vice chancellor, and a senior official from the business and innovation services department. On the P&G side, there were regional and scientific directors from the R&D functions and finance. While these members possessed significant scientific expertise, there were also several members on the Durham University side

that had significant experience working within commercial laboratories and across scientific disciplines. They can recognize the potential for inter-disciplinary collaboration within Durham University, as well as within the organization and a variety of external partners. In terms of project definition, they possess a cross-functional capability to connect diverse knowledge sources.

The meetings were often focused on providing expertise to align the mutual benefit for both organizations. There were often discussions about potential opportunities to explore and recent project matching/generation of ideas. If a potential idea was agreed upon, the conversations focused on the development of proposals and the development of work packages. This phase was overlooked by the corresponding senior members of the board that had relevant expertise to the project scope. They became responsible for collaborating across the organizational boundaries to ensuring that the project scope, the proposal process, and the resource needs were defined and communicated to the board. This process was fundamental in ensuring that projects were appropriately designed to ensure benefit for organizations. Additionally, these members needed to recruit appropriate individuals to carry out the duration of the project. They served as gatekeepers into the wider institutional structures of both organizations.

6.3.1 The Role of Durham Business and Innovation Services in Fostering Internal Collaboration

The Durham University Business and Innovation Service was formed to provide support services for research governance and commercialization activities across the entire university. The activities within this department provides guidance in terms of policy, funding applications, external engagement, and many research governance issues. It serves as a lynch pin to the research environment, as it is designed to focus on the complexities of budget complexities, requirements of grant proposals, university policies, and the transfer of intellectual property on a very broad scale, as the university engages with many external entities. While it is not unusual for universities to possess such a department, this department has cited as being highly effective in generating value for the university through the assistance they have provided in developing spin-out companies, commercializing technologies, sourcing opportunities for external engagement, and connecting resource pools across discipline. As such, this department is highly lauded by members within the network and was often referred to as a core element of the network effectiveness through the duration of this research and by many members.

This department acts as network orchestrators in connecting pools of knowledge across organizations and facilitates the communication of formal and informal expectations. This department is heavily involved in the early stages of project design and resource allocation, and has been fundamental in designing and managing the overarching governance and complexities mentioned in previous chapters. There were several dedicated members of this department possess intimate knowledge of both Durham and P&G's technology capabilities and can connect areas of expertise across the organizational boundaries. They possess accumulated knowledge of each partners' capabilities and expectations, which aids them in fostering dialogue necessary to build relationships and act as a liaison to provide guidance on the formal governance mechanism throughout the projects timeline.

Although they have minimal involvement after the project has initiated, they play a significant role in the exploratory phase of connecting new knowledge sources in strategic ways and to enhance heterogeneity among the knowledge sources. For instance, this department focuses heavily on ensuring that the partner has an initial point of contact for new project scopes. They also facilitate workshops and communications that allow a breadth of individuals to be engaged and (potentially) learn from the network. They are also intimately aware of future opportunities for collaborative opportunities and sources of external social capital. They enhance the appropriate connectivity and have substantial impact on learning, innovation, and performance (Tsai and Ghoshal, 1998).

While there are several members of this department providing support to this relationship, there is a specific individual that provides extensive guidance. This individual possesses intimate knowledge of the formal routines required by both organizations, and exhibits high levels of dedication to the effective functioning of the network. This individual has the trust of many members within the relationship, and serves as a relational champion by assessing project proposals and linking them with the commercial needs of the organization. This person became involved with the relationship from the very early stages and has been engaged with the overarching governance since the initial projects formed. Several members of the relationship attribute the successful functioning to this individual's unique capabilities and motivation to engage, with several members on either side stating that their contributions *"have been absolutely vital"* and that the organization has not observed many individuals working in technology transfer operating with such a high level of effectiveness.

The university business literature frequently addresses the topic of the performance and effectiveness of the technology transfer offices, and often suggest that they operate with differential abilities in achieving value creation (e.g. Breznitz, S., 2011). Scholars contend that culture and the willingness to engage (O'Shea et al., 2005; Plan & Siegel, 2006) impact the alignment and effectiveness of engaging with commercial opportunities with external business relationships. The individuals within the Durham University Business and Innovation Service often operate off the remit of contracts, however they exhibit high levels of commitment to ensuring that network is provided with resources.

6.3.2 Value Creation in University-Business Relationships

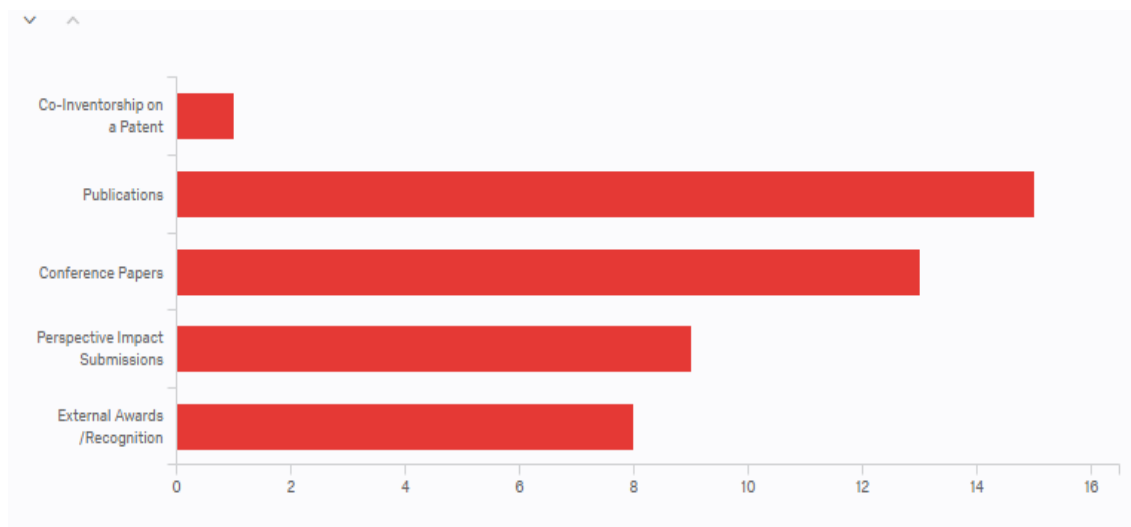
Prior to the presentation of the network structure, this research project aimed to identify the ways in which value was achieved for the partners. The research in this area typically values the effectiveness of this relational type based on intellectual property and publication output. Emphasising intellectual property as the core source of value creation within this relational type can impact perceptions of what constitutes quality and outcomes, however the interpretation of innovation outcomes and success are often subjective and locally specific to an organization (Conway & Stewart, 2011). It also can obscure the view of what constitutes mutual benefit. There is considerable evidence that open innovation does not always result in value creation or mutual benefit, as external ideas may not always align with the internal objectives of either or both firms (Parliament, 2014; Cohen & Levinthal, 2006), indicating that there are prevailing misinterpretations of how value can be achieved within this form of relationships presents a considerable amount of risk for partners.

The process to which the knowledge generated between a university and a business achieves intellectual property and publication can often take 2-3 years. For organization operating in dynamic markets, this may be viewed as a slow and ineffective approach to generating innovations. However, the literature review identified a potential benefit that is frequently overlooked. Generating innovation activities lies within the firm's ability to purposely renewing internal held knowledge stocks and to stimulate internal knowledge generation and creativity (Schumpeter, 1942; Cooper & Schendel, 1976; Henderson, 1993; Chandy, Prabhu & Anita, 2003) with the human capital accessible to the firm (Field, 2003).

However, the course of the qualitative investigation revealed several learning related benefits emerged that have significant benefits to a firm's internal activities and are often understated in the literature. For instance, when asked about the frequency of learning, 75 %

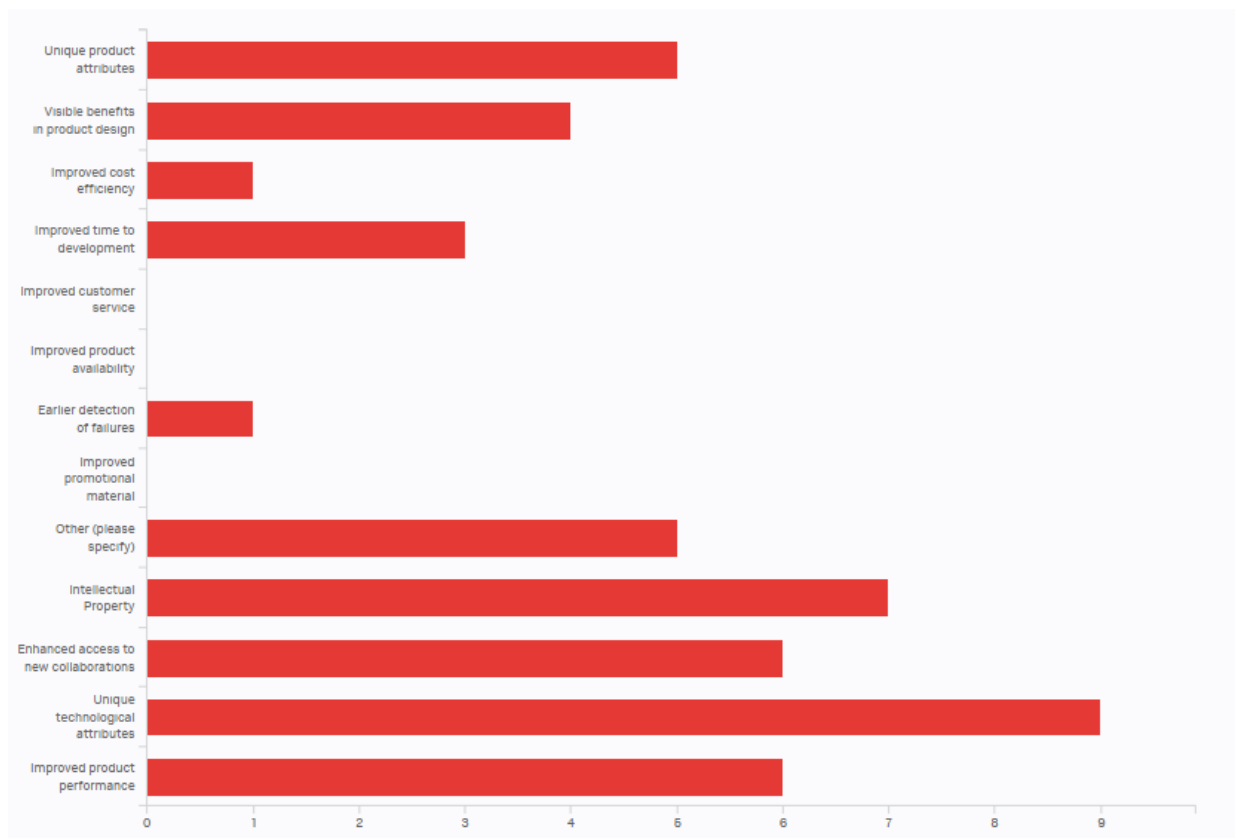
of Durham University and 67% of Procter & Gamble respondents indicated that they learned something new from the relationship at least once a quarter. The terms of performance outcomes were also not limited to intellectual property or publications that often emerge at the end of a project timeline, which is often between 2-4 years. Indeed, the performance assessment for this type of relational exchange is multi-faceted. (Please refer to figure 16 & 17 for an overview of value creation).

Figure 17 – Value Creation for Durham



The value creation for Durham academics extends beyond these measures. Interview participants and evidence from the qualitative investigation cited the value of the unique learning environment for students, which enhance and improves employability skills for those interested in industrial careers (such as within R&D departments). Several members of the network also commented that the challenges provided by P&G are interesting and they are motivated to engage with this network for intrinsic reasons.

Figure 18- Value Creation for P&G



Members from P&G commented that the relationship provides value in terms of greater understanding of not only the pure academic and basic scientific understanding of certain products, but also in locally specific technological science and is an under-appreciated benefit in the literature and in practice. Frequently, the literature cites that performance is related to the volume of patents or publications that emerge through the duration of the relational exchange. There is also the prevailing assumption that this form of relation exchange serves as an inbound knowledge source for commissioning research or engaging in mere tech transfer. However, the development of locally and technological specific knowledge for the organization requires bi-directional knowledge sharing. A strong example of the ways this relationship captures value from the enhanced technology specific knowledge generation were the technology transfer meetings. Many projects operating within this relationship are provided with research conducted within the R&D functions inside the organizations. Through sharing this information, the scale the knowledge mapping and acquisition accelerates learning and performance. Additionally, commentary from the board has emphasised that the breadth of knowledge exchange and the access to multi-discipline source of knowledge has provided

shorter project timeline, especially within the remit of uncertain areas of exploration. The scale and scope is providing efficiency. However, this is only one aspect of value.

The pure science provided significant benefits to the internal learning processes at the organization as well. While these projects often operated within a more uncertain realm, they offered the organization with greater understanding of current activities and enhanced their capability in their day to day functions. One interview participant stated that the knowledge exchanged during regular meetings provided them continual opportunities to learn and that projects did need to be fully completed for them to gain improved performance in their activities. It is apparent that the analysis of intellectual property and publication records are not the only value creating aspects of this relationship, however this has been under appreciated in the literature and practice.

6.4 Network Cohesiveness

Previous sections discussed the methods in which the partnership facilitated the collaborative relationship utilizing qualitative observations. This section begins by providing objective displays of the network functioning utilizing social network analysis of the formal governance mechanisms (the contracts). This was analysed based on formal mechanisms and the required task inter-dependence, as stipulated in the master agreement (contracts). This provides an interesting backdrop, as the literature emphasises contracts as the approach necessary for developing university-business relationships. If this was a purely transaction based network these visualizations would represent the nature of the collaborative exchange. As mentioned in section 6.3.2, the breadth and depth of the knowledge exchange is a significant benefit to industry. This provides efficiency benefits in several ways, e.g. scale and scope, shorter project timelines, and the stimulation of internal knowledge generation for human and intellectual capital development, through which learning could be impacted by the cohesion and range of the network structure (Reagans & McEvily, 2003).

Cohesion is a network concept that describes the extent to which connections are accessing the other elements bound within the network by way of connection to other members (Wasserman & Faust, 1994; Hanneman & Riddle, 2005). A network is said to have a high level of cohesiveness if the relationship are tightly bound and member can easily access other members without traveling great distances. A common approach to assessing the level of cohesion within the network is through the calculation of the density score. Within a graph, the density is calculated through analysing the optimal number of connections possible with the

actual connections within the network. With 1 being the optimal valuation, and 0 indicating no connections (Prell, 2011). The formula for calculating density is:

$$d = \frac{L}{n(n-1)/2}$$

(Please refer to figure 19 for density score)

Another commonly applied formula for understanding the cohesion within a network analysis is the constraint score. This score is determined through the analysis of the nodes with the highest level of centrality. Those nodes are assigned a level of hierarchy, and the computation assesses the level of density surrounding the most centrally positioned nodes (actors) to determine the level of limitations that individual faces in connecting with disparate ideas (Robbins, 2012). This formula was the basis of Burt's (1992) structural-hole argument. He states that managers with a high level of constraint are exposed to excessive redundancy in the ideas that are available to them. The constraint score for the entire network is determined through a sum of all the connections constraints. The formula for that measure is:

$$C_{ij} = (P_{ij} + \sum_q P_{ij}P_{qj})^2$$

(Please refer to figure 19 for constraint score)

A final measure utilized in this investigation for understanding the cohesiveness of the network was the geodesic distance. Essentially, this measure aims to understand the ease at which one node (actor) can connect to other node by way of traveling through the connections (edges) between them. This measure was popularized through the small world and six degrees of separation theory, which states that on average nodes are never as far apart six walks (links) within their network. This measure is most appropriate when applied to large populations, however it can be useful for understanding the ease of access in less densely connected networks. The formula for that measure is:

$$Y_{ij} = (N - 1) / D_{ij}$$

(Please refer to figure 19 for geodesic distance score)

Figure 19 - Overview of Network Cohesion

	Potential	Visible
Connections	18,560 Possible	852
Density Score	.3 is typical	.05
Constraints	0 is ideal	.5
Geodesic Distance	6	7 within the clusters

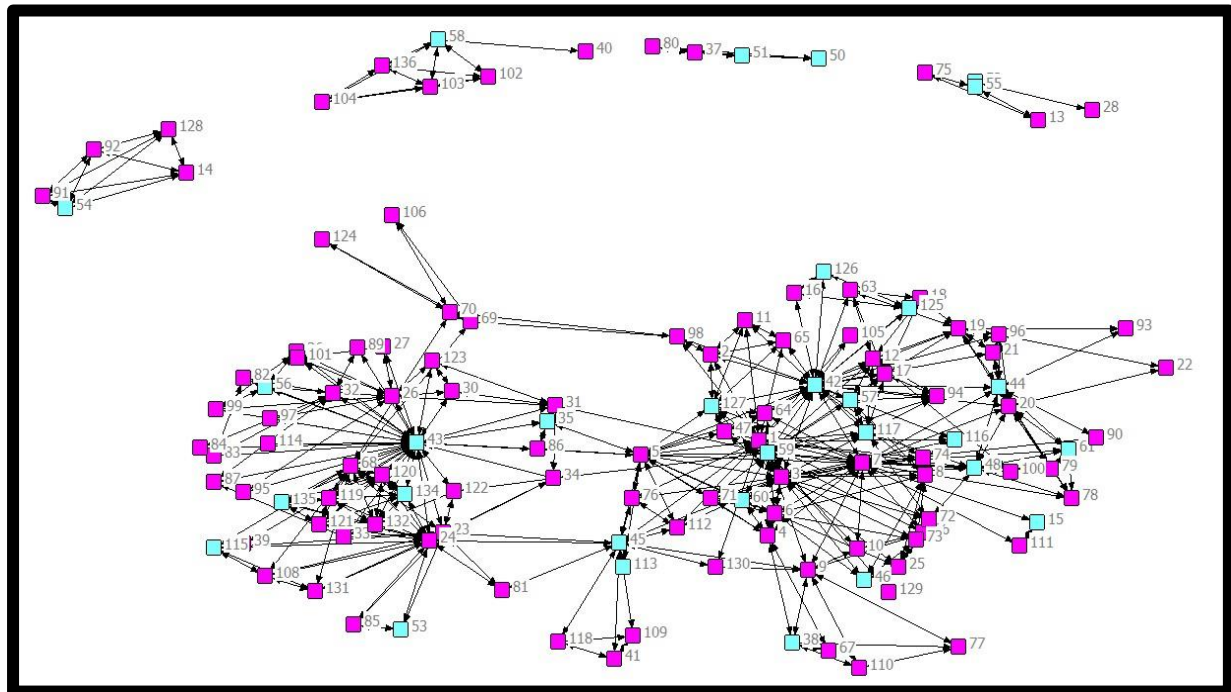
The analysis of the formal network structure (as dictated by the contracts) indicates low level of cohesiveness and connectivity in terms of network measures. The socio-matrix developed for analysis on non-directional dichotomous ties based on contractual relational linkages. Relationships were binary coded and lacked the ability to provide the volume of contextual information regarding the development of relational behaviours. While it reflects a low level of network density, the qualitative investigation suggests that the informal network activity facilitates deeper integration.

Based on the qualitative investigation and observations made, the impact of informal (non-contractual) interactions significantly impacts the density and shortens the geodesic distance within the network. Evidence from the qualitative investigation further suggests that an over focus on contracts obscures the representation of the activities occurring within the relationship that contribute to value. For instance, the technical meetings and workshops often bring together a wide range of members for joint problem solving. During these meetings, expertise is often offered beyond the remit of contractual obligations. Within the network, there is a normative behaviour to not only share personal intellectual capital, but also to connect potential links to external social capital and expertise. This is further enhanced through the depth of integration by the partners. There are several key members from P&G that serve as the gatekeeper to the wider organizational structure. (Please refer to figure 20)

Figure 20 represents the degree to which network members from P&G and Durham are integrated within the network. The binary socio-matrix was input into UCInet and display using the Spring Embedded feature. The blue nodes are P&G members, the purple is from Durham. While it seems apparent that the P&G members are centrally located, this represents an inaccurate view of the depth of knowledge sharing that occurs. For instance, the contracts reveal 139 members are involved in the relationship. However, the qualitative investigation revealed that potentially over 240 members have provided guidance and knowledge sharing.

These ‘unsung heroes’ are from either side of the relational exchange and provide social capital benefits to the network.

Figure 20 - Partner Integration

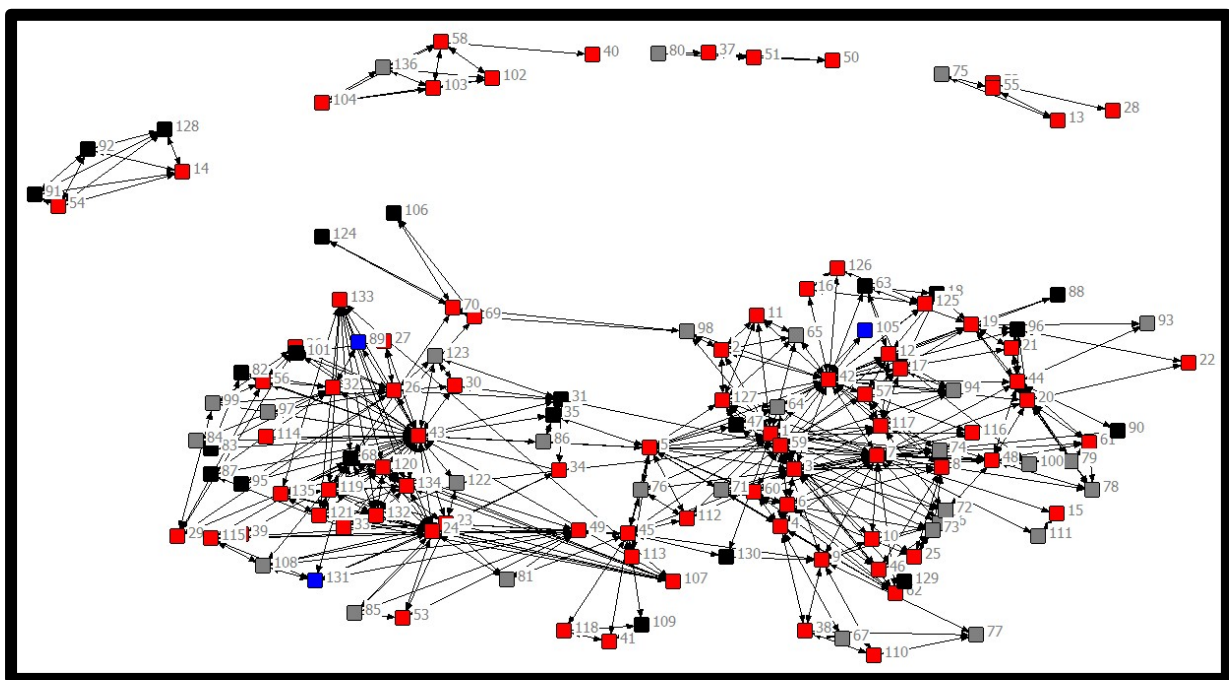


The objective displays created through developing a contract-based social network analysis will be complemented with qualitative observations to enhance the understanding of the true nature of the relational context and exchange. Indicating that it is not possible to identify all the contingencies associated with a relationship to develop a contractual arrangement prior to implementation or fully build a formal social capital structure, and emphasizes the importance to consider behavioural elements (e.g. trust) and the development of social capital as the theoretical explanation for how partnerships can be maintained (Zaheer et al., 1998). The remainder of the representations of the network within this chapter serve as visual aids in describing the content and structure of the relational exchange, and further supported with qualitative evidence.

6.5 Role and Prestige

The network literature focuses on the characteristics and levels of that centrally located actors have upon a network. this relationship has an underlying hierarchal structure and chain of command. The contract analysis was adapted to determine if differential access was provided to the actors of higher career qualifications. While it seems intuitive that PhD students would exist along the peripheral of the network, Figure 20 reflects that access does not appear to be entirely impacted. (The nodes were labelled red for expert, blue for technician, black for postdoc, and grey for phd researchers.) Please refer to figure 21.

Figure 21 - Career Level



This analysis reveals the significant levels of expert resources available within this network and contributing to the projects and the development of students. However, the rigid boundaries of the hierarchal structure assumed are less clear within the network of activity and the access to resources. As stated earlier, one of the benefits cited by an interview participants for the university was in the invaluable experience for the students to access a unique learning environment that contributed to their employability, and this evidence supports that the students can access a unique level of expertise through collaborative work. Additional evidence from the qualitative investigation suggests that the PhD students provide a level networking impetus for some of the members. For instance, developments in a PhD project deepened the exchange between several of the established experts' relational ties through the joint problem solving sessions and their 'network accessing' behaviour when requiring expertise for analysis. The

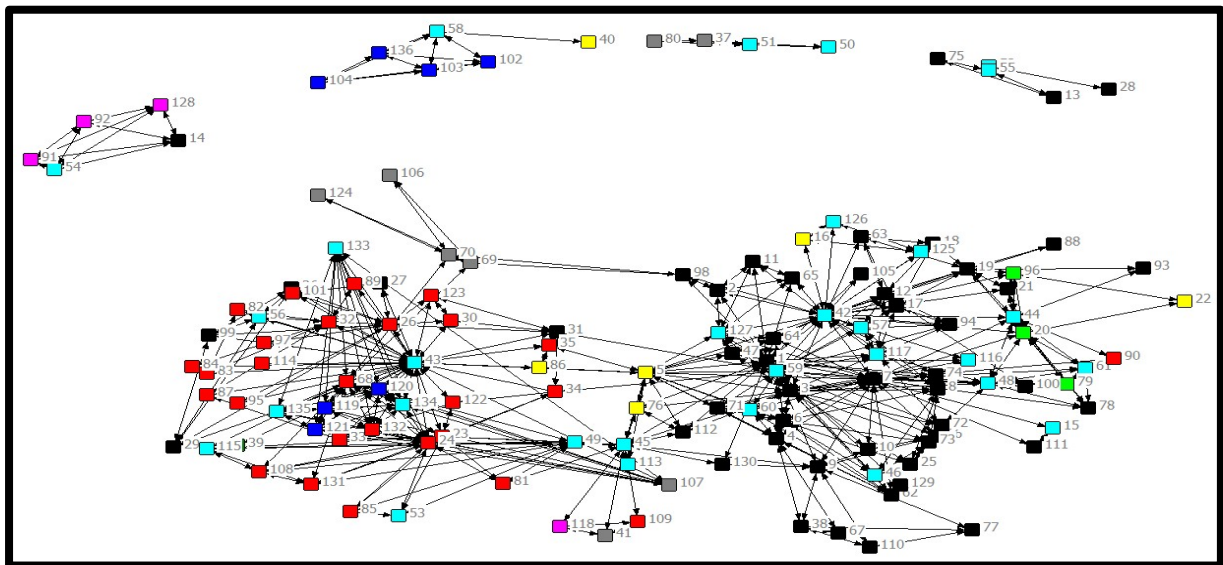
students became aware of the different streams of project scopes through the joint problem solving session and often linked their needs with other experts working on the projects. As the entire relationship was bound by the master agreement, the students could freely connect between the members when needed.

This is interesting in a couple of ways. For instance, this action is fundamental in the process of creating new knowledge and may contribute to the innovation process within this network significantly. Through connection previously disparate source of knowledge (Hargadon & Sutton, 1997), the students might be directly or indirectly ensuring that a level of vitality sustains in the innovation process. As suggest by Nahapiet & Ghoshal (1998) innovation performance and outcomes are associated with the capability to connect new knowledge to previously held knowledge stocks and making either radical or incremental new combinations. Additionally, prestige and ranking are typically viewed as an economic resource, as network rank is almost as valued as material resources (Huberman, Loch, & Onculer, 2004). However, the level of access to differential resources does not make a large impact on the students within the network. The next section considers how the various scientific disciplines connect.

6.6 Accessing the Multi-Discipline Knowledge Content and Diversity

The access to multi-disciplinary access has been cited as a significant benefit for both Durham and P&G. The formal overarching agreement has been built to allow for key points of differentiated knowledge resources to merge within the network, for example the scale, the project scopes, and the potential for collaboration across the diverse sources of knowledge. However, there are risks to the organizations capabilities to tap into this diversity if the overall structure reflects academic divides, there needs to be an integrating mechanism to access all expertise across the relationship. While the network is connected, there are different functional roles which illustrate clear boundaries between the different departments. Per the contractual analysis, there is a risk departmentalization of the activities being conducted, which has the ability to impede network integration.

Figure 22 - Knowledge Diversity



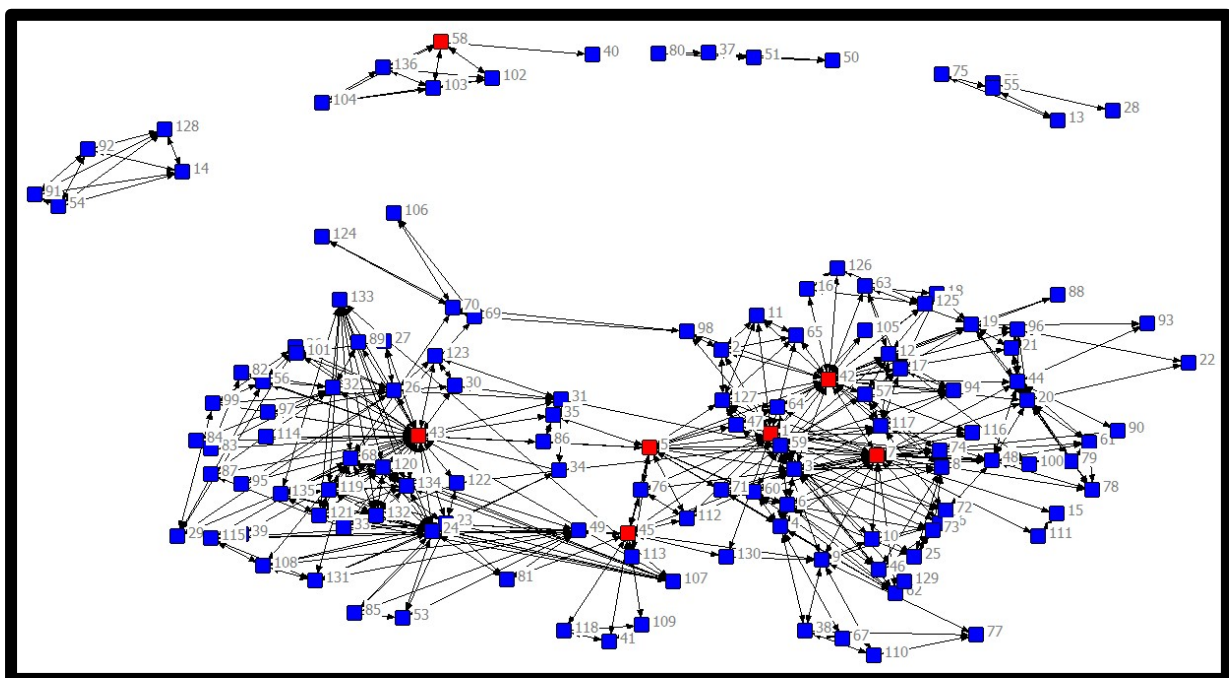
The analysis also revealed that actors within this network are not entirely isolated to disciplinary pockets, nor is there a solitary network structure. However, some actors have assumed a role to maintain interactions across the various subgroups and have a high level of influence on knowledge flows. While effective in the present functioning, there is a danger of over-reliance on key actors; which may cause burn out, stress, or network disintegration should they cease to be involved as well as group-think as the networks become more embedded (Heider, 1958).

The qualitative data also revealed additional risks of the group will becoming segregated, as they will be visiting P&G offsite locations. For instance, training will be individual, rather than a group effort decreasing the opportunity for informal interaction. The accomplishments will likely to be largely individual, rather than a group effort. The potential for collaboration and joint problem solving will be reduced and the multi-discipline ‘focus’ may be harder to keep. This is an effect of a newly established requirement for a project. This project is still in the early phases, and there seems to be difficulties in encouraging participation.

6.7 Knowledge Bridges or Cut Points?

While the analysis thus far illustrates the potential for accessing the range of knowledge resources available within the network, there are certain aspects of the relational exchange that might pose risk to the flow of knowledge and innovation. As mentioned in the literature review, knowledge transfer includes complex elements (e.g. technology) as well as informal elements (e.g. culture and normative behaviour) (Davenport & Prusak, 2007; Price, 2007) which directly impacts the capability for knowledge to be shared (Kogut & Zander, 1992; Tsai & Goshal, 1998; Tsai, 2001). Please refer to figure 23.

Figure 23 - Knowledge Brokers



This graph reveals the level of reliance that falls upon certain key players that play a significant role in connecting the network activities. These individuals play a significant role in ensuring that the multi-discipline access occurs as they connect the various scientific networks (McEvily & Zaheer, 1999). However, there is a risk of network disruption should the individuals become burned out or experience network overload (Marriotti & Delbridge, 2012). While this is only an illustration of the contractual elements and responsibilities, these individuals bare a great deal of responsibility to ensure the sustainability of the network.

6.8 Chapter Discussion

The university-business open innovation literature frequently emphasizes formal (contract-based) governance mechanisms for this relational exchange. This chapter aimed to characterise how access to knowledge-related benefits, in the form of innovation, may emerge within a functioning and sustainable university-business relationship. It is well established the knowledge sharing provides partner firms with the potential to gain mutual opportunities and benefits for innovation through inter-firm cooperation (e.g., Kogut & Zander, 1992; Tsai & Goshal, 1998; Tsai, 2001). The objective was to define how individuals might be integrated to share and access knowledge resources within this form of network, which is frequently overlooked within the university-business open innovation research.

Therefore, this chapter began by illustrating the extent of the formal exchange through a social network analysis. The formal structure of the network is coordinated in a way that encourages opportunity among the members. This merely illustrates the network connectivity among actors' specific functions, which has been assumed to be the guiding force in facilitating the generation of the knowledge and innovation outputs. As illustrated, the formal structure is coordinated in a way that encourages opportunity fluidity among the members. However, there is evidence of distinct variance among the actors' positions and the density of their connections, which has implications for how each of the individual members obtain or pursue the opportunities (or constraints) available within the relationship (Burt, 1995; Granovetter, 1973).

The evidence of the actors' formal contracts and their assigned task interdependence only reveals an average of three required connections, but knowledge creation can be dependent on the collaborative processes and social activity developed within the organization. The observations made from this analysis reveals that there are potential points within the network that could facilitate deeper collaboration through the usage of integration mechanism. The presence of structural holes and the facilitation of greater centrality amongst the actors has the potential to generate novel and new knowledge connections if the integration mechanisms are effectively executed. However, the appropriate usage of integration mechanisms requires a deeper understanding of how to effectively design and address the underlying and informal behaviours of network actors, as well as the actors' perceptions regarding the network functioning (Ng and Feldman, 2010). Network opportunities across functions and the knowledge focuses amongst the actors. The successful generation of innovative outputs within this research site reveals that although the network has been built strategically, operational effectiveness relies on other forms of social obligations that exist beyond the contract.

Within the network, knowledge based clusters have naturally formed. However, some actors have assumed a role to maintain interactions across the various subgroups and have a high level of influence on knowledge flows. While effective in the present functioning, there is a danger of over-reliance on key actors; which may cause burn out, stress, or network disintegration should they cease to be involved as well as group-think as the networks become more embedded (Heider, 1958).

Based on this level of analysis, the density score for the entire network was at 5% and characterised by a high level of weak linkages. However, evidence from the qualitative phase of data collection indicates that connectivity is far more developed and characterised by deeper collaboration. The transactional/formal network analysis reveals that the relationship in general has promoted an overall level of connectivity that promotes general knowledge diversity. However, there are many aspects of attributional data that have the potential to undermine access. Once these elements are introduced and analysed, and these segments have the potential to facilitate collaborations and/or create fissures in the overall relational design. Additionally, observations from the analysis also revealed that there are potential points within the network that could facilitate deeper collaboration through the usage of deeper integration mechanisms, allowing for a strategic view of network opportunities across functions and the knowledge focuses amongst the actors. For instance, the presence of structural holes and the facilitation of greater centrality amongst the actors has the potential to generate novel and new knowledge connections if the integration mechanisms are effectively executed. However, the appropriate usage of integration mechanisms requires a deeper understanding of how to effectively design and address the underlying behaviour of network actors, as well as the actors' perceptions regarding the network functioning.

The development of overly formal structures and institutionalized organizations (Meyer & Rowan, 1977; Allen & Strathern, 2005) have the potential to create network barriers to knowledge exchange (Dyer & Hatch, 2004a) and have the potential to limit knowledge creation and problem solving governance (Felin & Zenger, 2014), and appropriate connectivity can have substantial impact on learning, innovation, and performance (Tsai and Ghoshal, 1998). However, management practices also can have the unintended consequences of precluding collaboration. Bringing people together does not indicate that they will share knowledge nor communicate. Too tightly connected may cause bottlenecks and people can become connected to other people that know the same thing.

This becomes more complex within inter-organizational networks, as firms are apprehensive to share core elements of product design with external entities (Kline, 2003) and fear for knowledge spill overs (Athuana-Gima, 2005; Knott, 2006) (as related to the discussion on the resource based view in section 2.2.2) and create rigid process that undermine innovation performance. Alternatively, some research suggests that firms that adopt fully organic and complex responsive systems to enhance knowledge flow and innovation within networks (Stacey, 2001; Katz, 2006; Sorenson, Rivkin, & Fleming, 2006). Thus, supporting knowledge creation and sharing in networks (Cross et al., 2001) involves developing normative behaviours and communities of practice that motivate learning and innovation (Brown & Duguid, 1991; Belenzon & Schankerman, 2014).

Relational capabilities (e.g. trust and interaction) must be developed to address the desire to protect resources, yet foster the knowledge exchange required for innovation (Kale, Singh, & Perlmutter, 2000) and enable the heterogeneous knowledge to flow within the network (Knott, 2003). Therefore, fostering this act of knowledge sharing has been associated with the organizational climate (Bock et al., 1994) that promotes acceptance and acclimation of innovation (Myer & Goes, 1988) and knowledge combination capability within inter-organizational networks that relies upon relational capabilities (Carmeli & Azerouli, 2009) and appropriate responses to various external factors.

While the transactional analysis reveals that the relationship in general has promoted an overall level of connectivity across disciplinary focuses, the cohesion and the density misrepresented if the analysis was to rely upon a transactional focus alone. This genuine cohesiveness was illustrated by triangulating the qualitative observations and attributional data. This has several implications for the literature.

The qualitative evidence that supplements this investigation suggests that the informal networks extend beyond the market based incentives and nearly double the network size, thereby contributing to innovations processes by increasing the diversity of knowledge resources and functional support that is vital for new product development but is often overlooked. This re-emphasises the importance of the open innovation literature and the university-business literature to recognize the social and human complexities of inter-organizational alignment in research and practice. While focusing on the complexities of contract development and formal governance mechanisms are important in the assessment and early alignment of this form of relational exchange, this represents an obscure view of value

can be achieved (in terms of innovation performance) and relational development. There is an imperative to assess informal network structures to ensure appropriate functioning.

There are significant difference between the formal and informal structures which the social network analysis revealed (Cross et al., 2001). The informal (or internal) structure is embedded in what is known as the hybrid network structure. The informal relational ties are characterised by a variety of inter-personal relations with varying degrees of strength. It is theorized that formal and informal structures influence the development of each other in cyclical nature. Therefore, this thesis addresses the call made by Kadushin (2011) to illustrate what the informal network looks like and how this informal network facilitates collaborative behaviour, such that it results in value creation, innovation, network growth, and sustained results. The evidence supports the theory that this relationship is characterised by multi-relational contingencies and is, therefore, benefited by the access that is granted to the informal connections developed between the human actors. For the purposes of this chapter, the informal interactions are characterised by organically sourced support and knowledge acquisition behaviours observed during the qualitative investigation. This study finds that the informal connections provide significant benefits, e.g. nearly doubles the network size, encourages greater resource sharing (mutual benefit), and increases the diversity of knowledge resources and functional support that is vital for new product development. Therefore, the informal network has the potential to explain the true nature of collaboration beyond the contractual elements.

CHAPTER 7 CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

7.1 Synopsis of the Study

This thesis focused on exploring and describing the relational complexities of open innovation (OI) networks built between university-business research collaborations. There are significant organizational differences between a university and a business, as well as important distinctions between the pursuits of academic and commercial research. The variance in paths to knowledge generation for each of these research objectives, suggests that there is potential for complexities within opportunity identification, definition, creation, coordination and management of activities in a way that result in mutual benefits for both partners, let alone in the alignment of organizational cultures and effective management practices (Kogut and Zander, 1994). While current research acknowledges the potential for University-Business open innovation relationships, they are often portrayed as merely a link to knowledge access or financial resources. This thesis focuses on sociological issues that surround the alignment of such diverse partners and the route to generating novelty and, therefore, on the complex human and social elements that must be aligned and coordinated to access, release and generate knowledge necessary for novel outputs (Rodan and Gullunic, 2004; Nonaka, 1994; Kogut and Zander, 1992).

The process of connecting a university and a business is complex. Universities are governed and influenced by significant external pressures, and hold significant responsibilities to the knowledge generation for societal (e.g. BIS, 2012). While universities have proven their capabilities to develop technologies with commercial viability, there has been evidence that more research is needed to improve the effectiveness of their ability to engage with industry (e.g. Parliament, 2014). While there is a growing body of literature on the practice of university-business relationships, there are only limited studies that consider aspects of inter-organizational relationships. To the researcher's knowledge, there has not been a study that focused on the functioning, development, influencing factors, and the outcomes of this type of relationship.

This study aims to address this research gap by utilizing network theory to identify the various types of social capital structures, relational exchanges, and various behavioral components which effect flows of knowledge resources and innovative outputs; and thereby offer a theory extension by merging the social capital and open innovation literature. Social capital theory proposes that value is embedded within the patterns of relational exchanges that

exist within a network and directly effects knowledge creation, innovation development and outputs. The relational exchange selected for examination was a highly-publicized, effective and large scale University–Business relationship that has been built over a period of five years and has maintained high levels of mutual benefit and satisfaction.

The research adopted a holistic view of the internal network as the unit of analysis for this case study. This allowed the researcher to derive meaningful characteristics and descriptions of the phenomena being studied (Yin, 1994). This approach offers several advantages, such as providing a complete description of the topic being studied and disclosing contrasting positions without imposing the researcher's personal biases (Silverman, 1993) and yields benefits of uncovering disparate positions within a real-life context in that it adds meaning to the characteristics of contemporary phenomena, and are more appropriate for how and why questions (Eisenhardt and Graebner, 2007; Gibbert et al., 2008; Stake, 1993). The case study selected is cited as unusually high functioning, highly publicized, and has been operationally effective for four years. As suggested by Stake (1995) this case has the potential to provide rare insights warranting its study and can be instrumental to inform other case studies and provided a compelling backdrop for analysis.

This study seeks to combine the macro and micro level views of a network to fully illustrate the interactions between the formal and informal social capital that exist among actors. As such, a social network analysis methodology was adopted to map the patterns of social interactions occurring between and within the formal and informal social capital structures and their implications (Kadushin, 2012; Cross and Parker, 2004; Hanneman and Riddle, 2005; Burt, 1995; Wasserman and Faust, 1994; Granovetter, 1973). This methodological approach has the ability to objectively display the contingencies of how knowledge and knowledge resources flow among actors in the network by illustrating the various relational channels (Prell, 2011). This approach emphasizes the importance of identifying the features of a social structure that influence collective action and the flow of interactions between actors define the phenomena of interest (Hanneman and Riddle, 2005). Analysis of these features aids researchers to understand how opportunities or constraints may emerge in the social structure (Adler and Kwon, 2002; Burt, 1995; Granovetter, 1973) utilizing concepts to characterise the nature and depth of social relations (Hanneman and Riddle, 2005). This study seeks to identify and map the relational elements that enable (or constrain) the cross-functional resource flows that enable innovation and define the interactions between network

structure, content, and behavior. The next section resolves the overarching research questions of this study.

7.2 Resolving the research questions and propositions

The research questions underpinning this study develop from the gap in the literature for university-business open innovation research and the appreciation of the complex aspects of relational context and social contingencies in the generation of innovation outcomes utilizing a network theory lens. The open innovation frequently identifies universities as potential innovation partners. But, they are frequently referenced as a source of inbound open innovation. This section will respond to the initial research questions that served as a backdrop for this thesis.

7.2.1 Research Question 1

To what extent do theories of network structure, content, and behaviour individually and in unison explain value creation within university–business relationships?

(PIA) The structure of the network will reveal value creating aspects of a university-business network.

This proposition is supported. The structure of social relations can be defined in various ways. For instance, Chapter 4 focussed on how the network developed and evolved over time, yet it revealed the dynamic nature of network growth and emphasised the structure should not be viewed as a static element in relational design. Chapter 5 focused on the extent to which social structures are embedded within wider social systems. This analysis reveal that the extent of influence of external parties is significant in terms of developing knowledge and relational exchanges. Chapter 6 The transactional/formal network analysis reveals that the relationship in general has promoted an overall level of connectivity that promotes general cohesiveness and knowledge diversity. However, this cohesiveness is undermined when aspects of attributional data are introduced and analysed, and these segments have the potential to facilitate collaborations and/or create fissures in the overall relational design. Additionally, observations from the analysis also revealed that there are potential points within the network that could facilitate deeper collaboration through the usage of deeper integration mechanisms, allowing for a strategic view of network opportunities across functions and the knowledge focuses amongst the actors. For instance, the presence of structural holes and the facilitation of greater centrality amongst the actors has the potential to generate novel and new knowledge connections if the integration mechanisms are effectively executed.

(PIB) The content of the knowledge exchange found within the university-business relationship will impact value creation.

This proposition is supported; however, the content of the knowledge being exchanged would not have happened without the development of relational capabilities. While content specific goals foster a level of communication and exchange, this function would not be sufficient in terms of developing a relationship alone.

(PIC) The behaviour of the individuals embedded within the network will impact value creation.

This proposition is largely supported. As illustrated in chapter 4, the development of behaviours over time ensured the longevity of the relationship and the capacity to collaborate involved many behavioural features and social complexities; particularly the development of trust and adaptive processes that allowed flexibility to the changing external environment. Chapter 5 reveals the dynamic nature and the extent to which actors in this type of network must be capable of adapting to a wide variety of networks embedded within networks. Chapter 6 illustrated the impact of the informal network and how behaviours shaped the relational exchange outside of formal process. Thus, this supports the theory that knowledge creation and sharing in networks involves developing normative behaviours and communities of practice that motivate learning and innovation (Brown & Duguid, 1991; Cross et al., 2001; Ng and Feldman, 2010; Belenzon & Schankerman, 2014).

(PID) The behaviour of the individuals embedded within the network(s) and their content specific capabilities will impact the value creation in the network structure in university-business relationships.

This proposition is supported by multiple levels of evidence throughout the chapters. The relational capabilities (e.g. trust and interaction) was developed over time to address the desire to protect resources and fostered the knowledge exchange required for innovation (Kale, Singh, & Perlmutter, 2000). The initial development of the network facilitated adaptation and could avoid the formal structures that have the potential to create network barriers to knowledge exchange (Meyer & Rowan, 1977; Dyer & Hatch, 2004a; Allen & Strathem, 2005). As frequency and performance gave light to behaviors, norm reciprocity emerged and facilitated a strength in collaboration. The content and behavior facilitated growth and ensured sustainability of the network structure. As the structure became more embedded and strengthen,

it began to influence the content and behavior. Therefore, an assessment of all three factors provide a more complete view of how value is created in this form of relational exchange.

7.2.2 Research Question 2

Given the complex interactions in network structure, content, and behaviour, can firms coordinate and manage networks to derive innovation rewards?

(P2A) Complex interactions can be coordinated for innovation rewards.

To a degree, a core finding is that the formal network and facilitation mechanisms do not explain the true nature of the exchange. However, the master agreement and the activities of the Board only facilitate relational exchange among the members. The formal structure can be developed to encourage network diversity and to address issue of structural holes. However, it is evident that while these activities insulate the micro-level network from institutional pressures, too rigid processes undermine the process of innovation. The willingness of participants and the degree of informal social capital can be facilitated through influencing norms of reciprocity, knowledge, and resource sharing, and recruiting members that have levels of intrinsic motivations. As evidenced in the analysis, the informal structure facilitates this form of exchange.

7.2.3 Research Question 3

In what way might network structure, content, and behaviour interact to form a richer understanding of university–business relationships?

(P3A) Network structure and content interact to create value in university-business relationships.

This proposition is partially supported. The formal network structure can be strategically coordinated to address knowledge needs. However, the sustainability and growth of the formal network is reliant upon other networks structure types.

(P3B) Network structure and behaviour interact to create value in university-business relationships.

This proposition is supported. As trust is developed, key members become more deeply embedded within the relationship and gain greater connectivity both in the formal and informal network structures. This is a benefit in terms of facilitating socialization processes and

knowledge sharing of normative behaviours, however it could also pose risks should these core people be overlooked in their importance.

(P3C) Network content and behaviour interact to create value in university-business relationships.

It is evident from the analysis that the clusters have begun to form around scientific disciplines. This presents some level of risk to the networks key point of capability and advantage, in which there are significant opportunities for knowledge diversity by ensuring that activity is not occurring within silos.

(P3D) Network structure, content, and behaviour interact to create value in university-business relationships.

While all propositions are supported for this question are supported, it becomes evident that the genuine ‘story’ that emerges from this analysis is that of one that attempts to align all of these elements into a single analysis. It is evident that structure, content, and behavioural components coalesce to provide a richer view of how value is created within the micro-level process of this network type. It emphasises the social and relational complexities necessary to coordinate the release of knowledge resources within an innovation networks. To the researcher’s knowledge, there has not been another study that has focused on the network content, structure, and behaviour of a university-business research collaboration. This thesis aims to contribute to this gap by providing this overview of the relational context.

7.2.4 Research Question 4

What features of a network relationship can then be replicated and transferred to establish new value creating relationships and what might be local or specific to a relationship?

(P4A) All aspects of university-business relationships can be replicated and transferred to establish new value creating relationships.

There are some elements of the relational exchange that can be replicated and transferred to establish new partnerships. For instance, chapter 6 illustrated that value creation is not limited to intellectual property. The act of collaborating with a university stimulates and provides resources to the human and intellectual capital development within the firm on a frequent basis.

Additionally, a replication of the master agreement and the formal coordination of multi-discipline knowledge content within the structure provides a basis for trust development and knowledge diversity.

Finally, the depth of integration and the commitment to collaboration must be made to facilitate the innovation. However, this contingency is also reliant upon the development of behaviours.

(P4B) All aspects of university-business relationships are localised or specific to a relationship.

There are some elements of this network that might be only be local contingent. For instance, each partner had pre-existing capabilities and common dissatisfaction with the development of this relational type. Also, the development of the informal network might be specific to the culture of the relationship. The alignment of cultures between a university and a business is complex. Also, the responses taken to further stages in the network development may have only been specific to the current external pressures.

7.3 Discussion of the Analysis

There are three empirical studies in this thesis. The first empirical study within this project focuses on revealing the dynamic and self-organizing processes in which the relationship was built. A chronology and thematic analysis of archival documents, interviews, and participant observations reveals that development of the relationships was characterized by four transitional phases, an approach that was adapted from Cross & Parker (2004). This extension reveals of theory reveals the complex contingencies and periods of dynamic change the facilitated the development and coordination efforts.

The analysis began with an overview of pre-existing platforms and motivational triggers that fostered early development of the relational exchange. Several scholars contend that the success or failure of strategic relationships is dependent on the existing similarities between the organizations. Several contingencies existed including prior academic-industry experience, institutional pressures, and constrained resources. However, it is not possible to identify all the contingencies associated with a relationship to develop a contractual arrangement prior to implementation, and aims to present evidence of how trust and the development of social capital are appropriate theoretical explanations for how partnerships can be enacted and maintained (Zaheer et al., 1998).

The analysis then moves to discuss the ways in which the network developed over time by reviewing the phases of development and tipping points that stimulated dynamic change and focus within the social context of the organization (Greiner, 1972; Mintzberg, 1984; Gladwell, 2002). The successful transition to further stages in network development was dependent on the appropriate responses and actions taken to the tipping points. From the analysis, there have been four major tipping points that were identified and resulted in the further stages of development of the network: initiation, relationship building phase, maintenance, and renewal. Each phase presented a new challenge that required complex social processes to be coordinated; which had implications for the network structure and operational focus, and demanded actions to shift the organizational focus and to maintain the vitality of the relational exchange for continued value creation. An over focus on rigid mechanisms and planning processes might dilute the adaptive nature which contributed to network growth. This network addressed these obstacles by being flexible. Rigid planning procedures may have reduced the ability to be responsive to changes. These findings suggest that multifaceted adaptive processes are essential, but are often overlooked in network studies.

A significant theme that emerged from the analysis in chapter 4 was the need to continually engage with external institutional forces and to continually manage legitimacy through all phases of the network development. The group needed to define the tools that were necessary to communicate the 'how' and the 'why' effort should be expended on development to a wider audience, indicating that the network activity extends beyond the partner organizations and has an impact beyond the boundaries of the relational exchange. However, as the universities connect and their network increases in complexity, a potential for network overload emerges (Marriotti & Delbridge, 2012) and may undermine the ability to develop the integration and relational linkages that are necessary for the complex knowledge transfer (Uzzi, 1996, 1997) associated with innovation development.

The second empirical study focuses on clarifying a common conceptual problem that occurs within studies of open innovation, inter-organizational partnerships, and university-business relationships. Studies of networks often select members within a relational dyad as the focal point for investigation, and overlook the extent to which external entities might impact relational behaviour. The definition of boundaries and influence of network activities is likely to make considerable impacts on the observations. Research using network approaches could enhance the development of the field if they explicitly define the characteristics of the boundaries selected and the other options. A key theme that emerged from this investigation

was that the influence of external networks and weak ties impacts the internal network behaviour in significant ways. In coordination with the former empirical study, the volume of stakeholder influence and the reaction to external pressures dictates development and decision making process, and thus the value creation.

The third empirical study of the project aimed towards identifying the formal structure and mechanisms that are utilized to foster the relational exchange. An asymmetric dichotomous socio-matrix was crafted utilizing archival documents and financial records to illustrate obligatory task interdependence and knowledge access across the disciplinary sub-groups within the network (e.g. chemistry, biology, physics, etc.). Based on this analysis, the density score for the entire network was at 5% and a high level of weak linkages. However, evidence from the qualitative phase of data collection indicates that connectivity is far more developed and characterised by deeper collaboration. The evidence from this investigation suggests that the informal networks extend beyond the market based incentives and nearly double the network size, thereby contributing to innovations processes by increasing the diversity of knowledge resources and functional support that is vital for new product development but is often overlooked.

The formal structure of the network is coordinated in a way that encourages opportunity among the members. The formal network structure was defined by contractual arrangements and the obligatory task interdependence as outlined in the Master Agreement. This merely illustrates the network connectivity among actors' specific functions, which has been assumed to be the guiding force in facilitating the generation of the knowledge and innovation outputs. As illustrated, the formal structure is coordinated in a way that encourages opportunity fluidity among the members. However, there is evidence of distinct variance among the actors' positions and the density of their connections, which has implications for how each actor obtains or pursues the opportunities (or constraints) available within the relationship (Burt, 1995; Granovetter, 1973). The appropriate usage of integration mechanisms requires a deeper understanding of how to effectively design and address the underlying and informal behaviors of network actors, as well as the actors' perceptions regarding the network functioning (Ng and Feldman, 2010). Network opportunities across functions and the knowledge focuses amongst the actors. The successful generation of innovative outputs within this research site reveals that although the network has been built strategically, operational effectiveness might rely on other forms of social obligations that exist beyond the contract.

This chapter aims to illustrate the contributions of the informal relational linkages to the network's functioning through triangulating the social network analysis conducted on the formal network structure with qualitative observations. This also addresses the call made by Kadushin (2011) to illustrate how the informal network facilitates collaborative behavior, insomuch that its prevalence results in value creation, innovation, network growth, and sustained results. Therefore, an analysis of the underlying informal relational linkages has the potential to explain the nature of collaboration beyond the contractual elements and the true nature of the relationship can be further characterized by multi-relational contingencies and is, therefore, benefited by the access that is granted to the informal connections developed between the human actors. The informal relational ties are characterized by a variety friendship, support, and knowledge acquisition behaviors to reveal the varying degrees of strength and the correlations between the social capital type. This study finds that the informal connections nearly doubles the network size, and increases the diversity of knowledge resources and functional support that is vital for new product development but is often overlooked, thereby offering an extension to the open innovation literature.

7.5 Scholarly Implications

This study has implications for the open innovation literature, as it aims to provide an alternative theoretical lens into how open innovation networks might function to provide value creation. Much of the literature has an over-reliance on economic based assumptions and market based explanations to developing a network of this type, however this focus may overlook the body of work on how social factors influence how innovation, knowledge generation, and information flows might be unlocked and developed between partnering organizations. This study offers a theory extension to the open innovation literature, as it reveals that the complex aspects of establishing a sustainable OI network. This study also has implications for the university-business literature, as it reveals the complexities of managing the different modes of commercial activities. This study also has implications for the social capital and network theory literature, as it reveals that informal and behavioural components embedded within the nodes composition will have a significant effect on the potential outcomes of the network performance. The social capital literature frequently emphasises the importance of measurement and tie strength, and but has the potential to overlook the potential impact of the behavioural mechanisms.

Finally, this study has implications for researchers utilizing social network analysis. As it reveals the extent to which relational context has the potential to contribute to the examination of network function.

7.6 Implications for Managers and Policy Makers

The practical implications of this thesis are many. First, this thesis proposes that the current recommendations made at policy, management, and scholarly levels so far about the effective organisation, operation, and management of university–business collaborations are leading to an incomplete and abstract view of how value is and is not created within these partnerships. Whilst many authors have emphasised the complexities and benefits of university-business relationships, there is relatively little guidance in how these benefits might emerge following the initial negotiations and knowledge ownership issues. This study reveals the complex contingencies necessary when coordinating, developing, and maintaining collaboration within this network type. It involves developing strategies that allow for adaptation.

The chapter that focused on network dynamics (4) reveals that relational development between a university and a business is not static or confined to simple market mechanisms. By reviewing the development of a network over time, this study provides insight into the dynamic and ever-changing roles managers and policy-makers have. One ensuring functionality and performance emerged during the doctoral research was the need to continually engage with external institutional forces and to continually manage legitimacy through all phases of the network development. The group needed to define the tools that were necessary to communicate the ‘how’ and the ‘why’ effort should be expended on development to a wider audience, indicating that the network activity extends beyond the partner organizations and has an impact beyond the boundaries of the relational exchange. In terms of assessing the external environment, managers should be aware of the nature of university-business relationships. Phase of network development challenge the social processes to be coordinated; which has implications for the network structure and operational focus. An over focus on planning processes and contract negotiations might dilute the adaptive nature which contributed to network growth. These findings suggest that multifaceted adaptive processes are essential, but are often overlooked in network studies.

Chapter 5 provides an overview of the extent of network activities that contribute to university-business relationships. This provides practical guidance that allows managers to

assess the extent to which a partner university will have access to additional social capital to contribute to project outcomes to aid in the initiation phases and negotiations of project scopes. Also, it reveals the structure of relations that might be necessary to ensure that a large-scale collaboration is fully supported.

Chapter 6 provides insight into the micro-level interactions that contribute to value creation within this form of open innovation relations. This guidance provides practical guidance in the ways in which formal task interdependence might result in value creation. While the literature frequently emphasizes the potential for intellectual property, an effectively designed university-business relationship might stimulate internally held knowledge stocks and benefit the business in several ways.

7.7 Reliability, Validity, and Limitations

Data collection techniques involved multiple sources of evidence, such as documents, interviews, and participant observations, enabling triangulation to enhance the reliability. The usage of multiple methods was intended to improve the researcher's capability to enhance the reliability of the generalizations.

The key limitation to social network data is the ability to generalize social phenomena to other social situations. Although the data collection techniques and analysis followed a robust research design, there are limits to determining the applicability of this relational structure based on the analysis of the 'local' interaction. Future work could be used to extend this analysis for cross case analysis. Additionally, data access to the entirety of the external stakeholders would have benefited the analysis of the open systems that influence this network but was beyond the scope of this study.

Finally, there is a risk of the social desirability response. People have a tendency to respond in a way that intends to make themselves look good and most people in cohesive groups think of themselves as superior members (Myers & Lamm, 1976). It is a form of legitimizing self-image and enhancement and may serve as form of intrinsic motivation among the network. The success of the activities of one group filters through to the other group due to in-group membership and the representations of the self. This form of in group favouritism aligns with the theory of BIRC (bask in reflected glory). Within 'in-group' membership, achievements are identified among the group members as a whole. Ingratiation is trying to convey the impression of being likable, and self-promotion, competence display and are two of the most common goals of social interaction (Arkin, 1981; Lerner, 1995). Therefore,

respondent validation and member checks to share data with some of the participants will be necessary. Key informants checked the validity of statements during the composition phase. Where appropriate for data validation or clarification, interviewees were approached for a second, follow-up interview (Gephart, 2004, Miles and Huberman, 1994).

Chapter 6 was intended to include objective measures of the informal relational ties for additional analysis, however the survey response rate has not yet produced a high enough volume to be considered a reliable representation of the whole network. Future work will aim to improve the response rate to collect and analyse reciprocation and influence within the network. Future research might aim to merge the social capital literature with the literature on the impact of cognitive processes on network performance.

Additionally, future work could review the network dynamic utilizing objective displays of the contractual (formal) network and align with the phases for a deeper analysis of the interaction between formal and informal social capital development. Also, this research revealed that external institutional forces deeply impact universities. Future studies might review the variations between the impact policy and legal requirements have upon the functioning of university-business relationships.

Finally, the role that the PhD students have upon the network and the innovation process appears to have a significant influence. Future research can focus on the role of peripheral actors in open innovation networks. This theme aims to illustrate the contributions of the informal relational linkages and less central actors within the network's functioning to further understand how they facilitate collaborative behavior, insomuch that its prevalence results in value creation, innovation, network growth, and sustained results.

APPENDIX 1 – Semi Structured Informed Consent

PARTICIPANT INFORMATION SHEET

PROJECT TITLE

Crystalizing the nexus of network structure, content, and behavior for innovation rewards in university and business relationships: A study of the P&G and Durham interface

WHAT WILL HAPPEN

In this study, you will be asked a series of questions regarding your involvement with the relationship.

PARTICIPANTS' RIGHTS

You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed.

You have the right to omit or refuse to answer or respond to any question that is asked of you.

You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

BENEFITS AND RISKS

There are no known benefits or risks for you in this study.

FOR FURTHER INFORMATION

Dr. Mat Hughes will be glad to answer your questions about this study at any time. You may contact him/her at

INFORMED CONSENT

By signing below, you are agreeing that: (1) you have read and understood the Participant Information Sheet, (2) questions about your participation in this study have been answered satisfactorily, (3) you are aware of the potential risks (if any), and (4) you are taking part in this research study voluntarily (without coercion).

APPENDIX 2 – Cross Sectional Survey Informed Consent

Informed Consent

The purpose of this survey is to collect information about the network of relationships between P&G and Durham University. This is to help understand best practice and how value is created in this vital strategic partnership.

The questionnaire consists of 32 questions and will take approximately 20 minutes or less to complete.

Participant rights:

- Participation in this research study is voluntary.
- The data collected will be stored securely and password protected.
- All survey responses will be anonymous and assigned a private identification code by the researcher only for the purposes of data matching and analysis. Your responses will only be reported in an aggregate form with all other responses.
- Only the primary investigator (Stephanie Scott) and supervisory team (led by Dr. Mat Hughes, Durham University Business School, with Dr. Paul Hughes and Dr. Paul Burrows) will view the anonymous data, and access will be maintained solely by the primary investigator
- There is no direct compensation for participants. However, with your participation, P&G and Durham University will learn how this strategically vital relationship operates and creates value.
- If you have further questions regarding this study, please notify the principal investigator (Stephanie Scott) at +44 754 154 3294 or s.a.scott@durham.ac.uk.

APPENDIX 3 – Semi Structure Interview Protocol

3.3.1 Network (Social Capital) Development Stages

Chapter 5 addressed the calls made by recent studies, which have called for a focus on relational behaviour (Hughes et al, 2014) and social capital development behaviours (Ng and Feldman, 2010), because the extent to which value can be created from opportunities presented by network content and structure can only be realised through the behaviour of the individuals acting within the social system. It aims to provide a temporal perspective of relational context and changes over time. The research investigation provides an extension of Cross & Parker's (2004) stages of network development framework and reveals evidence of adaptive processes.

The following are the research questions that guided the study in chapter 5:

1. How does a university-business coupled (open innovation) relationship evolve over time?
2. How often do partners in university-business coupled (open innovation) relationships interact? And, in what context?
3. How can a university-business coupled (open innovation) relationship be organized in terms of structure and content?
4. What are the prevalent themes of communications between university-business coupled (open innovation) partners?
5. What are the roles of actors in the university-business coupled (open innovation) relationship?
6. How and in what context did actors become involved (or dissolved) in the university-business coupled (open innovation)?
7. Is a university-business coupled (open innovation) a self-organized network?
8. How are university-business coupled (open innovation) partnerships governed?

9. How do university-business coupled (open innovation) partnerships react to change?

3.3.2 Network (Social Capital) Boundaries

Chapter 6 aims to reveal the variations in the boundaries and approaches in analyzing a university-business network. It aims to reveal the extent of the potential resources that may become available in the open system (Laumann et al., 1983; Wasserman & Faust, 1994). This approach is compared with an overview of the micro-level networks designed for knowledge exchange. This aims to that alternative approaches limit the boundaries to individual level (Sedita, 2008). Finally, the types of relations (Kilduff & Tsai, 2003) and the units of measurements (Sedita, 2008) utilized in studies have significant variations. This is made more complex research suggests significant variations across organizational settings (Ahuja, 2000; Provan et al., 2007) which make them more difficult to manage and coordinate (Doz & Hamel, 1998).

The following are the research questions that guided the study in chapter 6:

1. To what extent is the university-business coupled (open innovation) partnership influenced by external actors?
2. What types of external influences directly impact the focal university-business coupled (open innovation) partnership?
3. How many external influences directly impact the focal university-business coupled (open innovation) partnership?
4. What are the roles of the external influences that directly impact the focal university-business coupled (open innovation) partnership?
5. To what extent and in what context does the focal university-business coupled (open innovation) engage with external networks?

5. To what extent does the network boundaries extend into either partner's organization in university-business coupled (open innovation)?
6. How many actors are involved in the focal university-business coupled (open innovation) partnership?
7. What are the roles of the actors in the focal university-business coupled (open innovation) partnership?
8. What is type of content is being shared in the focal university-business coupled (open innovation) partnership?

3.3.3 Formal and Informal Networks (Social Capital)

Finally, this thesis address calls by Kadushin (2011) for research to illustrate the difference between formal and informal social capital structures. **Chapter 7** investigates the formal structures are defined as obligatory task interdependence as stipulated by the projects and contracts.

The following are the research questions that guided the study in chapter 7:

1. Can university-business coupled (open innovation) partnerships utilize formal (social capital) coordination mechanisms? (e.g. hierarchies or contracts)
2. What are the implications of developing formal (social capital) networks in university-business coupled (open innovation) partnership?
3. To what extent does formal (social capital) networks contribute to innovation in university-business coupled (open innovation) partnerships?
4. What is the density of a strategically built formal (social capital) university-business coupled (open innovation) partnership?

This chapter also considers the impact of informal (social capital) elements. Informal informal structures were developed in term of relational elements, such as friendships, advice, and expertise. Additional, the informal chapter presents how members of university-businesses define value.

The following are the research questions that guided the study the informal section of this study:

1. To what degree is density impacted by informal relationships in university-business coupled (open innovation) partnerships?
2. To what extent does informal networks explain network cohesion in university-business coupled (open innovation) partnerships?
3. Do network actors connect with others not defined by their contracts in university-business coupled (open innovation) partnerships? And, in what context?
4. To what extent do network actors bring external knowledge sources into university-business coupled (open innovation) partnerships?
5. In what ways do network actors acquire and define value creation in university-business coupled (open innovation) partnerships?

APPENDIX 4 – Cross Sectional Survey Design

In order to ensure accuracy in data collection, please first enter your name in the below box.

Which organization are you a member of?

- ☐ Durham University
- ☐ Procter & Gamble

What is your age?

What is your gender?

- ☐ Male
- ☐ Female

As a member of Procter & Gamble, what best describes your current role?

- ☐ Technology Development
- ☐ Process Development
- ☐ Formulation Development
- ☐ Product Research
- ☐ Packing Development
- ☐ GPS (Regulation and Safety)
- ☐ Analytical Services
- ☐ Microbiology
- ☐ R&D Management
- ☐ C+D (Connect and Develop)
- ☐ Modeling
- ☐ Product Supply
- ☐ Other (please specify) _____

As a member of P&G, which of the following product categories is your work most focused on developing? (Multiple options have been enabled)

- ☐ Fabric and Home Care
- ☐ Beauty
- ☐ Baby, Feminine and Family Care
- ☐ Health and Grooming
- ☐ Corporate

How many years have you been employed with P&G?

How many years have you been employed at Durham University?

On a broad level, what best describes your personal area of scientific training and research expertise?

- ☐ Chemistry
- ☐ Physics
- ☐ Life Sciences
- ☐ Mathematical Modeling
- ☐ Engineering
- ☐ Management
- ☐ Psychology
- ☐ Other (please specify) _____

As a member of Durham University, what best describes your career level?

- ☐ Professor
- ☐ Reader
- ☐ Senior Lecturer
- ☐ Lecturer
- ☐ Technician/Research Fellow
- ☐ Post Doctoral Researcher
- ☐ PhD Candidate
- ☐ Director
- ☐ Support Services (please specify) _____
- ☐ Other (please specify) _____

As a member of Durham University, what best describes the department(s) that you work within?
(multiple choices has been enabled)

- ☐ Biological Science
- ☐ Chemistry
- ☐ Physics
- ☐ Business
- ☐ Psychology
- ☐ Engineering
- ☐ Mathematics
- ☐ Support Services (please specify) _____
- ☐ Other (please specify) _____

Prior to working in the P&G and Durham University relationship, how many years of experience did you have working within an industrial context? (e.g. time spent working in industry or time spent working with other industrial partners).

Prior to working in the P&G and Durham University relationship, how many years of experience did you have working within an academic context? (e.g. time spent working in Universities or time spent working with other Academic partners).

How did you first hear about the P&G and Durham University collaboration?

- ☐ Internal/Organizational Communications (e.g. posters, newsletters, intranet articles, etc)
- ☐ A colleague within your organization
- ☐ Managerial Advice
- ☐ A friend within the partner organization
- ☐ Public Press Releases
- ☐ Workshop
- ☐ Other (please specify) _____

When did you first get involved in the Durham University and P&G relationship?

- ☐ 2010 - 2011
- ☐ 2011 - 2012
- ☐ 2012 - 2013
- ☐ 2013 - 2014
- ☐ 2014 - 2015
- ☐ 2015 - 2016

Which option best describes the context of your initial involvement?

- ☐ A response to an industrial/commercial need.
- ☐ A response to a gap in academic literature.
- ☐ A response to governmental or societal agendas.

How many individual projects have you personally contributed to within this relationship?

As a member of P&G, approximately how frequently do you learn something new from the projects you have encountered? (This does not have to be measured specifically in IP generation. Please include an estimation of instances where you have received an improved innovation capability, for example).

- ☐ Never
- ☐ Less than once a year
- ☐ Once a year
- ☐ Once every six months
- ☐ Once a quarter
- ☐ Once a month
- ☐ Once a week

As a member of Durham University, approximately how frequently do you learn something new from the projects you have encountered? (This does not have to be measured specifically in IP generation. Please include an estimation of instances where you have received an improved understanding in your scientific knowledge, for example).

- ☐ Never
- ☐ Less than once a year
- ☐ Once a year
- ☐ Once every six months
- ☐ Once a quarter
- ☐ Once a month
- ☐ Once a week

As a member of Durham University, has your project(s) produced any of the following? (Please check all that apply).

- ☐ Co-Inventorship on a Patent
- ☐ Publications
- ☐ Conference Papers
- ☐ Perspective Impact Submissions
- ☐ External Awards /Recognition

Please let us know how many instances each.

As a member of Procter & Gamble, has your project(s) produced any of the following? (Please select all that apply)

- ☐ Unique product attributes
- ☐ Unique technological attributes
- ☐ Visible benefits in product design
- ☐ Improved cost efficiency
- ☐ Improved time to development
- ☐ Improved customer service
- ☐ Improved product availability
- ☐ Improved product performance
- ☐ Earlier detection of failures
- ☐ Improved promotional material
- ☐ Intellectual Property
- ☐ Enhanced access to new collaborations
- ☐ Other (please specify) _____

Approximately, what percentage of your time do you spend working on project(s) for this relationship?

Are any of your projects joint funded by a government agency or research council?

- ☐ Yes
☐ No

Of the time that you have spent working on this relationship, how much of your time is focused on the following tasks:

	0-20%	20-40%	40-60%	60-80%	80-100%
Administrative coordination (e.g. paperwork)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Collaborating with others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solitary research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supervising others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please tell us a bit more about your project(s) and indicate your scale of agreement with the following statements. If you have multiple projects, please generalize your response to encompass all work conducted within the network.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor disagree	Somewhat Agree	Agree	Strongly Agree
My project has met all of its goals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe that the project could have been better.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My project helped identify further opportunities for new projects.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe my project has created value substantial value for the partner organization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel guilty that my project(s) have not achieved the result that I wanted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am satisfied with my project(s) results.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe the partner organization is satisfied with my project(s) results.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please tell us about your personal preferences for sharing your research with the rest of the network by stating your level of agreement with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
When I have learned something new, I tell my colleagues about it.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When they have learned something new, my colleagues tell me about it.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find it easy to access the knowledge/learning necessary for my project to progress.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I have learned something new, it is easy to communicate my findings to the partner.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When the partner has learned something new, it is easy to understand how it effects my work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel like my work could be improved by greater opportunities for communication.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe that I know many people working on DU and P&G projects.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe that I have a strong understanding of the work that happens across all activities in this network.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have had many unique interactions in this network.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel as though the collaboration is a two way learning experience.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Tell us a little more about your personal preferences for networking. Using the scale below, please state your level of agreement with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
I spend a lot of time networking with new members in the DU and P&G relationship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'm good at building relationships with others in this relationship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I know a lot of people and am well connected to people in this relationship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find it easy to find someone to help progress my work in this relationship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'm connected to many people in this relationship that understand my work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I spend a lot of time meeting with this relationship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Using the scale below, please tell us about your personal research ambitions.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
I am ambitious to address commercial needs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am ambitious to address academic needs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There is always a way to fulfill a commercial need with academic research.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commercial research greatly benefits from academic research.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The partner always keeps the promises that they make to you.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The next set of questions are designed to help us understand the extent of the network growth beyond the core members of the relationship. Please tell us more about how you connect to new

people. External members can be described as people within Durham University or Procter & Gamble that may have not been included in the initial project team.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
I frequently find assistance from new people that were not previously connected to the relationship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have a large network of colleagues outside of this relationship that I can call on for support.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can think of many ways that my work would benefit non-competing partners.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel comfortable bringing new people into the relationship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that it is hard to bring new people into this network.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that new people bring valuable new insights into my work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I feel that external parties add too much pressure on to the work being done.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel comfortable seeking assistance from people external to this relationship.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does your project involve collaboration with partner organizations that extend beyond P&G and Durham?

- ☐ Yes
- ☐ No

How many partner organizations have you brought into the in the DU_P&G relationship for your projects?

- ☐ 0
- ☐ 1-2
- ☐ 3-4
- ☐ 5-6
- ☐ 7-8
- ☐ +9

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